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HOW THE SCIENTIST STUDIES VITAMINS*

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The subject of this talk is not exactly correct since every scientist interested in vitamins studies them in a slightly different manner and I would not attempt to review all of these various procedures. What I really want to explain today is how our knowledge about vitamins has been obtained. I feel that such a survey is valuable because many people have the idea that certain workers merely set out to find a new vitamin and sooner or later reach the goal which they have set for themselves. Our knowledge about vitamins is the result of intensive studies by a large group of investigators and we can trace the evolution of this information much like that in any other field of endeavor.

Specific information on vitamins developed from two fields of work: (1) the observations by medical workers that certain diseases could be associated with faulty diets, and (2) the studies by laboratory workers using inadequate or restricted diets.

I shall limit myself to one specific phase of the vitamin field—nicotinic acid and pellagra. I have chosen this subject not because nicotinic acid is more important than some of the other vitamins, but because I happen to know more about the details of this work. The specific disease, pellagra, has not been known for as long as some of the other deficiency diseases. Scurvy, for example, was described by Hippocrates and a treatise was written about the disease about 1750. Pellagra, on the other hand, was first recognized two centuries ago by Casal in Spain.

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One of the specific symptoms described by this worker is known as "Casal's necklace." The early symptoms of this disease are weakness, lassitude, anorexia, and indigestion, followed by a sore and ulcerated mouth, and finally diarrhea. A typical dermatitis is usually present and is most evident on those areas of the body which are exposed to sunlight. Severe mental disturbances often occur in many cases of pellagra.

A census in northern Italy in 1830 revealed that in many areas of that country five per cent of the population were suffering from pellagra. The disease was endemic throughout France from 1818 to 1880. A large incidence has also been reported in the Balkan States. During the past 50 years pellagra has been a definite problem in the United States. The first cases were recognized in 1863 by Gray in New York and Tyler in Massachusetts. The incidence of the disease in this country became so significant about 1910 that the Thompson-McFadden Pellagra Commission was organized to study this disease in South Carolina. A report of this Commission in 1914 contained the following statement:

"Pellagra is in all probability a specific infectious disease communicable from person to person by means at present unknown."

At that time the fatality rate was as high as 40% amongst pellagrins and the incidence continued to increase.

About this time Voegtlin postulated that there was a causal relationship between diet and the incidence of pellagra. In 1914 Dr. Rupert Blue, who was then Surgeon General of the United States Public Health Service, ordered Dr. Goldberger to take charge of the pellagra investigations. He was called from duty in Detroit where he was investigating an epidemic of diphtheria. Yet Goldberger and his coworkers were the first to show conclusively that pellagra can be prevented by means of an appropriate diet. They worked in three southern institutions in which a large number of cases of pellagra had occurred for several years. In the fall of 1914 the diets were supplemented with milk, fresh meat, egg, and dried beans. One year after this change had been made only one out of 244 pellagrins had a recurrence of the disease, whereas on the basis of previous experience a recurrence of about 50% was expected. Goldberger and Wheeler in 1915 produced typical pellagra in prison volunteers in Mississippi by placing them on a restricted diet. In spite of this work, many medical people were still convinced that

pellagra was not due alone to a deficient diet. It is unnecessary to continue a description of the experiments carried out by Goldberger to prove that pellagra was not an infectious disease. The fact remained that few, if any, pellagrins were cured by improved diet.

McLester in 1934 maintained that the death rate from severe pellagra remained high irrespective of the method of treatment.

Let us see what animal studies contributed to our knowledge of pellagra. By 1915 the rat had become a very common experimental animal. Goldberger was no ordinary physician and therefore attempted to produce pellagra in the rat by feeding diets similar to those consumed by humans in the pellagra area. He produced a rather specific dermatitis on such diets and found that it could be prevented by yeast and by autoclaved yeast. Since it was well-known that vitamin B_1 was destroyed by autoclaving, the anti-pellagra factor came to be associated with the heat stable component of the vitamin B complex. Other workers found that when chicks were used as the experimental animal, polyneuritis was obtained when vitamin B_1 was left out, but only failure of growth resulted when the rest of the B complex was omitted.

The English preferred to designate these two factors vitamin B_1 and vitamin B_2, but in this country vitamin G was introduced for the designation of the heat stable anti-pellagra factor in recognition of Dr. Goldberger's work. The anti-pellagra potency of foods was determined by following the growth response obtained when individual foods were added to the ration of rats because many workers had difficulty in producing the symptoms first described by Goldberger.

The rat was also used to some extent to follow the potency of various fractions prepared from yeast, but little progress was made. Today we may well wonder how any progress was made since we know that the rat does not require the anti-pellagra factor and that the B complex is made up of a fairly large number of individual components.

Fortunately the dog was introduced as an important animal in some of these nutritional studies. Chittenden and Underhill at Yale in 1917 found that dogs fed on a diet of crackers made from milled wheat flour, boiled peas, and vegetable fat, developed diarrhea, loss of appetite and ulcers of mucous membranes. These symptoms promptly disappeared when fresh meat was supplied. Later, identical symptoms were produced in dogs

fed diets similar to those eaten by humans in pellagrous areas. The condition was called black tongue and was considered to be similar to human pellagra. In 1934 Sebrell published values for the pellagra-preventing value of a few foods based on dog assays.

About 1930 liver extract, which was available commercially for the treatment of pernicious anemia, was found to be highly effective in the treatment of pellagra. Liver extract was more potent than yeast and therefore could be used more effectively in cases with severe digestive disturbances. This finding opened new approaches to the problem of pellagra. Shortly thereafter Goldberger and Sebrell found that liver extract was equally as effective in black tongue in the dog as it was in the treatment of human pellagra. Studies on the isolation of this factor were therefore initiated but they were not very extensive because of the difficulty in using dogs for assaying the various preparations.

At about the same time I was working in the biochemical laboratory in Cambridge, England and Dr. Guha, who was also working there, found the liver extract, which I had brought along for another purpose, produced excellent growth in rats on a vitamin B_2 deficient diet. At that time the vitamin B complex had not been divided beyond two factors—vitamin B_1, the anti-neuritic factor, and vitamin B_2, the more stable factor which was associated with growth in rats and human pellagra.

We now know that the growth obtained in this rat work was due largely to riboflavin which is separate and distinct from the anti-pellagra factor. Attempts in our laboratory to produce pellagra-like lesions in rats failed completely and we turned our attention to chicks. A pellagra-like condition was produced in the chick by feeding a heated natural grain ration and our fractions from liver were assayed with these chicks. I may add that this condition was first observed in chicks during experiments to study the relative value of plant and animal proteins. We continued concentrating this fraction and felt that we had obtained a rather highly active concentrate when a number of workers questioned our results and wanted to know what right we had to assume that this pellagra-like condition in chicks was a measure of the human anti-pellagra factor. It was therefore necessary for us to repeat our work using dogs since most authorities agreed that black tongue in dogs was identical with human pellagra. Our concentrates were also highly effective in curing black tongue in the dog.

Within a short period we demonstrated the activity of nico-

tinic acid in the cure of black tongue and isolated nicotinic acid amide from these liver extract concentrates. These observations were soon verified by a large group of workers including Street and Cowgill at Yale, Dann at Duke University, and Sebrell at the National Institute of Health in Washington, D. C.

You may wonder why our attention was turned to a study of nicotinic acid in our liver concentrates. Work in entirely unrelated fields gave us this clue. The compound, nicotinic acid, was first prepared in 1867 by the oxidation of nicotine. Forty-five years later it was isolated in crystalline form from yeast concentrates by Funk. This worker felt that nicotinic acid might be related to vitamin B_1 but it was soon shown to have no activity in curing pigeon beriberi. In fact, in 1917 Williams, who later isolated vitamin B_1 in pure form, was so impressed by the common occurrence of nicotinic acid with the anti-neuritic vitamin in several natural substances that he tried not only nicotinic acid put many related compounds for anti-neuritic potency but none of them showed any definite potency. Nicotinic acid, therefore, remained on the chemical shelf without being recognized as having any significant biological value.

Between 1930–1935 Euler, working in Stockholm, and Warburg and Christian in Berlin, began to isolate important coenzymes necessary for normal tissue metabolism. Warburg and Christian were studying a coenzyme in the red blood cells and soon found that when this substance was hydrolyzed, nicotinic acid amide could be characterized as one of the hydrolysis products. This work gave new impetus to the application of these compounds to the field of nutrition. A number of workers including those in our own laboratory, added nicotinic acid to a variety of diets used in experiments with rats. Naturally all of these experiments were negative since we know today that the rat does not need nicotinic acid preformed in the diet. By 1937 several workers had shown that nicotinic acid was an essential growth factor for certain microorganisms. Knight demonstrated it was an essential factor for *Staph. aureus* and Mueller showed its importance for diphtheria bacillus. These studies, therefore, led us to look for nicotinic acid in our concentrates and you can well imagine our surprise when pure nicotinic acid exhibited this profound effect in the treatment of black tongue.

The first report of the successful use of nicotinic acid in human pellagra was made here in Chicago just four years ago this month. Since that time thousands of cases of pellagra have been

treated through the use of nicotinic acid. These studies did not complete the pellagra program. It merely opened many additional investigations. First, let me tell you what happened when we went back and tried nicotinic acid on the chicks which we had used in our earlier studies. Our concentrates were highly active, but pure nicotinic acid showed no activity whatsoever. Further work demonstrated that the concentrates contained another factor which has now been identified as pantothenic acid and is the fifth member of the B complex.

Naturally the organic chemists were interested in determining if compounds having a structure similar to nicotinic acid would be active in the treatment of black tongue and pellagra. It appears that only those compounds possess anti-black tongue potency which are capable of oxidative or hydrolytic conversion to nicotinic acid in the body. Since the nutritional significance of nicotinic acid was recognized, it was generally assumed that its function in the animal body must be related to the coenzymes that I mentioned previously. This assumption has not been demonstrated to be true by experimental work.

Dogs or pigs suffering from nicotinic acid deficiency show a significant decrease in the coenzyme content of the liver and muscle tissue. However, we still do not know how this decreased coenzyme content produces the typical external symptoms associated with nicotinic acid deficiency.

Now we may ask what are the practical applications of these studies? I have already stated that nicotinic acid can be used in the treatment of pellagra, and in these cases 100–500 mg of the material is given daily to the patients until they show complete cure. However, from a nutritional point of view we are more interested in the prevention of pellagra than its treatment. If we are to accomplish this, we must know the distribution of nicotinic acid in our common foods. This necessitates an accurate method of assay. One might expect to find a simple chemical method for the determination of a compound such as nicotinic acid. Such chemical methods have been developed but are satisfactory for only certain types of foods. The method works quite well for animal foods, but plant materials contain interfering substances. Therefore, the only reliable method was the dog assay procedure which was long and tedious.

About six months ago a bacteriological method was developed by Snell and Wright, which has proven very satisfactory. During the past six months we have obtained more values for the

nicotinic acid content of foods than we obtained in the previous three years using the dog procedure. From values obtained it is quite simple to explain the prevalence of pellagra in the southern states. Corn, which is extensively used in these areas, contains 1 mg% of nicotinic acid, while other grains such as wheat contain 5 mg%. Much white flour is used in the southern states and 80 to 90% of the nicotinic acid is lost during the milling process. Another interesting fact is that all animal tissues are very rich in nicotinic acid and these results verify the original statement of Goldberger that the use of a small amount of lean meat will do much to eliminate pellagra. However, we still have the economic question, that people in these areas are unable to purchase sufficient meat. We have seen, therefore, within the past few months the introduction of enriched flour which contains added vitamin B_1 and nicotinic acid. The consumption of this flour or bread made from this flour will do much to eliminate the nicotinic acid deficiency in the southern states.

From this short story we can point out many interesting observations regarding nutritional research. Progress is made only when advances in other fields are applied to the problem in question. I suppose no one started an investigation with more enthusiasm or obtained more dramatic results than Goldberger but the final answer was not obtained because a pellagrin with severe digestive disturbances could not eat sufficient yeast or other foods rich in the anti-pellagra factor to supply an adequate amount of nicotinic acid. The animal work was limited because many workers struggled along with the rat which gave no help on the anti-pellagra factor but did allow advances in our knowledge of other B vitamins. The dog was an excellent experimental animal, but it took space, equipment and time to do much with such an animal. By introducing still another species, the chick, progress was more rapid but only due to the fact that nicotinic acid and pantothenic acid have similar properties and appeared in the same fractions. We also have the peculiar fact that nicotinic acid has been known for over 50 years, but remained on the chemical shelf without notice. Thus, it appears to be just as difficult to devise proper conditions to demonstrate the physiological role of a known compound as it is to find the compound in a preparation known to have physiological activity. In the case of nicotinic acid the active form of the compound in the living cell was recognized before the compound was shown to be an essen-

tial component of the diet. Thus no one can predict what type of experimental work is most valuable.

Few people would have expected to find bacteria playing such an important role in nutrition. As early as 1919 Williams concluded that the substance or substances which stimulate the growth of yeast on purified media is or are identical with the substance or substances which in animal nutrition prevent beriberi. But it was only when some of the newer members of the B complex, riboflavin and nicotinic acid, were studied that we recognized that many bacteria and microorganisms need the same vitamins that the animal does. Studies with the bacteria have not only helped us to identify new factors, but they are now being put to use in assay procedures. Further we are finding that the bacteria in the intestinal tract may play an important part in the synthesis of some of the newer vitamins.

Thus a single observation may often unite two apparently unrelated fields of scientific endeavor. In the case of nicotinic acid, the fields of nutrition and respiratory enzymes have been united with an increase in the rate of progress in both fields.

AMERICAN REPUBLICS UNITED IN WAR ON DISEASE

North and South America are marching hand-in-hand to victory over disease. Smallpox and yellow fever death rates have been sensationally reduced, bubonic plague virtually wiped out.

As disease decreases and appropriations for public health in the 20 republics other than the United States have more than doubled, since 1930, Americans everywhere are living longer, healthier lives.

These statements are summary of information on public health in the Americas just released by the Executive Office of the President, Coordinator of Inter-American Affairs, on the eve of Pan American Health Day. Special celebrations will mark this day in all the American countries.

The Coordinator points out that "only 11 years ago—in 1930—there were 17,900 deaths from smallpox in a single year in the American republics other than the United States.

"In 1940 there were 1,350. And, unless an epidemic develops, which is unlikely under present health controls, the figures will be much less for 1941.

"Eradication of bubonic plague is even more striking," the statement continues, pointing out that 65 port cities in 11 American republics have had plague infection between 1898, when it appeared in the Western Hemisphere, and 1940, inclusive. But by last year plague infection had disappeared from all except seven of those 65 cities. And of those seven, four which reported infection in 1940 have reported none this year—indicating a record of only three cities with plague. Of the three, one reports no human cases.

Appropriations for public health in the 20 republics other than the United States, have increased from $40,523,698 in 1930 to $93,535,481 in 1940 in terms of the U. S. dollar.

WATCHING WINTER BIRDS

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[Editor's note: The author, a writer of children's stories and verse, tells how to attract winter birds and describes some of their habits to observe. She has also included some verse that has an appeal to children and that can be used with winter activities related to bird study. In forthcoming issues of SCHOOL SCIENCE AND MATHEMATICS two more articles will appear entitled "Watching Spring Birds" and "Watching Summer Birds." Laura B. Young invites teachers who are further interested in stories and verse for bird study to communicate with her.]

We built our house in the woods, close to the burned ruins of an old farm mansion, the yard of which was a tangled mass of honeysuckle, wisteria, and old fashioned garden flowers.

Several kinds of syringa bushes that had been brought to Indiana by old settlers in the covered wagon days bloomed profusely—some of them very fragrant. Glorious purple and white lilacs, snowballs, and wild cranberry had grown year after year, with Nature the only caretaker. She was a wonderful caretaker. She made a haven for wild birds and small woods animals, offering them perfect seclusion and protection.

Among the huge oaks, stately elms, and sturdy maple trees were a number of black and white mulberry trees, the fruit of which attract many birds. Wisteria vine had grown to the tops of many of these trees. No wonder the birds loved it there!

The winter birds, both permanent residents and transients, were a joy and an inspiration.

They seem like family and home folks,
The birds that stay all year,
When the weather's cold and cloudy
We're glad to have them near.

Just a little food and water,
Placed where easily found,
Will keep them close in winter.
And they'll gladly stay around!

They know that folks are friendly
Who give them protection and care.
So they'll sing and chirp in the cold,
Though the trees are bare.

In winter they are friendly
When coming to us for food.
In summer they are a little shy
When raising their feathering brood.

The feeding shelter of boughs, well roofed, was built just out-

side the living room window, which we could raise to replenish food, water, and grit. Wild birds came for their first feeding early in the morning, even in the coldest weather.

If the grain we had placed on the shelf had been entirely eaten, the grackles would peck on the windowpane. They were the only birds that we saw doing this.

Beside the breakfast-room window was a beautiful American elm. On this tree we kept large pieces of suet, tied firmly to the trunk so the crows could not carry everything away at once. The meat-eating birds spent most of their waking hours on the bole of this tree. The grain-eaters would often come for a mouthful of suet, but for the most part these birds were members of two distinct groups.

Downy and hairy woodpeckers, white breasted nuthatches, chickadees, and brown creepers, each, in his own way, sustained life and warmth at the suet.

The downy woodpecker is black and white, with tail feathers barred at the edge. The male has a red patch on the back of his head. The foot has two claws in front and two in back. With these he pinches the bark and, with the support of his stiff, barbed tail feathers, he hops up and down the trunk easily, and stands still in an upright position for quite a long time. He drills a hole in the bark, thrusts in his strong, slim tongue with slanting hooks on it, and pulls out a grub or some insect eggs. His "peek peek" is often heard as he stops hammering for an instant.

The downy hammers at trunks of trees,
For insects hidden where
The bark is creviced and somewhat rough.
He is sure to find them there!

His tail he uses for a prop,
His toenails are very strong,
So he stands upright on trunks of trees,
And chirps his little song.

With his tongue so slender and long,
And his sharp and chisel-like beak,
He reaches into crevice and crack,
Hammers a while, then calls "Peek, peek!"

The hairy woodpecker is similar to the downy in habits, although in appearance he is about a third larger. Instead of barred tail feathers his are entirely white.

The brown creeper is a small but lively bird with brown, streaked back, and has white beneath. The tail is long and

barbed and he needs it for supprt as he travels up and around the tree trunk, stopping only to dig out food with his slender, curved beak. When he reaches the top he flies down, then starts up again and again.

The white-breasted nuthatch is a beautiful, graceful looking bird. He is bluish gray above, with white throat and breast, and he has a black cap on the back part of his head, towards the neck. His beak is long and slender, suitable for reaching into crevices for insects. To crack a nut or acorn, the nuthatch places it in a crevice of the tree bark, then hammers away until he reaches the kernel. The nuthatch has a way of going down a tree head first. He has strong, large toenails with which he digs into the bark. He moves very swiftly, and because of this is often called a "tree mouse."

Black-capped chickadees examine the twigs above, then look underneath for insects and eggs. They have a cheerful little winter song, "Chick-a-dee-dee-dee." They are very friendly and interesting.

Sometimes we would hear the "Caw, caw" of a crow, and hear the flapping of his great wings as he came for his share—and really more than his share—of grain and chunks of suet, which he carried away with him. When a crow came the other birds retreated until he was again on his way. After a few such visits we placed some of the suet in soap shakers, so the smaller birds would be able to always get their share.

Among the grain-eating birds, the cardinals are gentle and well behaved. They are very fond of sunflower seed, and easily crack it and other grain with their strong beaks. The male cardinal, even in winter, breaks up seeds for the female and treats her with great courtesy. His brilliant red plumage is like a flash of fire in the winter landscape. The female is much more subdued in coloring. Their "tsp, tsp" as they pick up seed, and their quick, jerky movements, are very interesting.

My yard was a palace
Of crystal and snow,
It swept from the north—
How the wind did blow!

I sat by the window,
When close to my chair
Came a beautiful bird—
A cardinal was there!

His lovely red plumage
Looked more brilliant still,

Because of the snow
On the window sill.

He lifted his crest, and
Without thought of fear,
He greeted me warmly, with
"Cheer, cheer, much cheer!"

The blue jay is a permanent resident—beautiful in his blue suit. He is rather bossy and likes to frighten the other birds off the feeding shelter. There is nothing gentle or even gentlemanly in his actions.

Sometimes a lone robin would come for an occasional meal, or perhaps he would stay around for two or three days. He would be either a late migrant or one who had decided to stay on and brave the winter weather, as a few of them sometimes do. He would seem rather shy and lifeless among the permanent residents, perhaps because the rest of his kind were gone.

Song sparrows were daily boarders. We could easily distinguish the song sparrow from all others by the large brown spot on his mottled breast. He would sing many cheerful, trilling songs all during the winter. Many of the song sparrows migrate, but a number of them stay all winter.

The tufted titmouse or tomtit, as he is sometimes called, is a gray-backed bird with lower parts light, having a black and white face. He has a pretty crest which he raises frequently. This reminds me of a person lifting his eyebrows.

Goldfinches or wild canaries are sometimes called thistle birds, because, building late in the season, they line their nests with down from the thistle. In winter, the male goldfinch has the same dull green plumage that the female has the year round. But he has a yellow shoulder patch, and the female an olive green patch. In winter they move southward, but more come from the north to take their places so they are considered permanent residents.

In winter we had very interesting little visitors coming down from the extreme north of our country and from Canada—the slate colored juncos or snowbirds. Traveling in small groups, they like to pick up seed from the ground, or from weeds and bushes. However, they came to the feeding shelter when the snow covered their weed supply.

The bronzed grackle is considered a winter visitor rather than a permanent resident. A few stay over or migrate from farther north. The grackle is not a songster, but makes a somewhat

squeeky, clanging noise. He takes long steps, pushing his head forward and swinging his tail as he walks. The grackle is greedy, but is not such a fighter as the blue jay.

The winter wren comes down from the extreme north. He is even smaller than our house wren. A queer habit of the winter wren is the bobbing of his head and the turning up of his little tail over the back, until the bird is almost overbalanced. Winter wrens are very shy, and at the slightest noise or movement quickly disappear.

Winter birds become more numerous and very friendly if we constantly keep food, water, and grit where they can find them. A bird bath is appreciated by them, even during cold weather. Protection from cats is helpful but not so necessary as during the nesting season.

Birds never cease to be interesting. Much has been learned by just watching them, and no doubt there is a great deal yet to be learned of their habits and ways.

I am sure birds sense when persons are friendly towards them. Even with their wild natures they have a trustful attitude which appeals greatly to the bird lover.

MEXICO IS TO HAVE NEW NATIONAL OBSERVATORY IN THE TROPICS

Mexico is building a new national observatory which will house a 24–30 inch Schmidt photographic telescope, the most powerful in the tropics, Dr. Bart J. Bok, astronomer of Harvard College Observatory, has announced in the journal, *Sky and Telescope*.

Other equipment will include a 12-inch reflector for visual observations and two or three cameras of the Ross type with apertures of three to five inches. All equipment will be purchased with funds provided directly by President Camacho of Mexico.

The observatory will be located on a hill ten miles south of the city of Puebla, which is 80 miles east of Mexico City. This is a very favorable location for observation of the southern hemisphere. Latitude of the observatory is 19 degrees north of the equator, which means that the sky can be seen to within 19 degrees of the south celestial pole. The site is nearly 8,000 feet above sea level.

The work of the observatory will tie in closely with that of the Harvard College Observatory and of the Mexican observatory at Tacubaya. It will consist largely of observations of southern variables and of star counts, colors, magnitudes and spectra for the southern hemisphere.

Director of the observatory will be Luis Enrique Erro, assisted by Dr. Carlos Graef, both of whom have already spent a year in work at Harvard College Observatory with its director, Dr. Harlow Shapley.

Formal dedication of the new observatory is expected to take place late in February.

A STUDY OF ACHIEVEMENT BY ENTERING COLLEGE FRESHMEN WITH REFERENCE TO SPECIFIC ELEMENTS OF KNOWLEDGE IN GEOMETRY

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The purpose of this study was to determine the degree of achievement by groups of different scholastic aptitude making up an entering class of college freshmen with reference to certain elements of knowledge in geometry. The results are presented in the belief that data of this kind should be of assistance to teachers in raising the level of pupil accomplishment in the subject.

SOURCES OF DATA

The subjects providing the data for this report numbered 442 and represented practically all but the repeating and transferring members of a freshmen class entering a state college for men located in the Southeast and enrolling about 1,200 students. The group was representative in scholastic aptitude and slightly lower than representative in mathematical ability of the freshmen entering colleges and universities in the region, according to respective comparative results on the American Council Psychological Examination, 1938 issue, and a standardized test in mathematics.[2]

The tests just referred to were those from which all of the data of this study were obtained. Both tests had been given as part of the regular testing program to which all entering freshmen are subjected. There remained to be determined, for this particular study, the results on individual geometry items of the mathematics test. Nearly all of the items were of the true-false form and it was decided to limit the items studied to this type. It was also decided to exclude from the study the few items peculiar to the particular test; also the few judged too complex to yield results sufficiently diagnostic; likewise those to which an insufficient number of subjects responded.[3]

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[1] The following students cooperated in the tabulation of the data: E. M. Adams, R. E. Bunch, A. D Edwards, C. W. Shuler, W. J. Logan, H. H. Walker, and J. R. Miller.

[2] Although the test is a 1925 edition, its identity should not be revealed.

[3] Preliminary computation revealed that 90% of the subjects had gone, in their reactions, at least three-fourths of the way through the series of true-false items; also the per cent of subjects actually responding to each item.

Treatment of Data

For each of the selected items the per cents of subjects responding incorrectly[4] was computed for (1) the entire group of 442 subjects, (2) the 125 subjects ranking highest in scholastic aptitude, according to results on the American Council Psychological Examination, and (3) the 125 subjects ranking lowest in scholastic aptitude. These per cents of subjects in error together with statements incorporating the specific understandings and misconceptions represented by the test items (but not the actual test items) are given in the table which follows.

Table Showing Specific Achievement of Subjects in Reactions to Geometry Test Items

Note 1: The true and false statements of this table are *not* the items of the test. They represent the specific knowledge and the misconceptions which were embodied in the test items and which are the common concern of texts and tests in the field.

Note 2: The statements are arranged in descending order of per cents of subjects responding to the corresponding test items.

No.	Specific Knowledge and Misconception	Per cent of Subjects in Error		
		Scholastic Aptitude Groups		
		All 442	High 125	Low 125
1.	It is possible for two straight lines to intersect at only one point	5	4	9
2.	A straight angle possesses 180 degrees.	4	0	8
3.	Circles possessing equal radii are equal.	2	0	5
4.	In the same plane two lines perpendicular to a third line are parallel to each other.	6	2	10
5.	A rectangle is a kind of parallelogram.	18	16	21
6.	The supplement of an angle of 45 degrees is an angle of the same size.	32	25	32
7.	The sum of the angles of any plane triangle equals two right angles	23	16	35
8.	Only one arc is determined by two points on the circumference of a circle.	35	36	45
9.	If a right triangle has a base of 3 and an altitude of 4, its hypotenuse is 7.	20	15	29
10.	Either remote interior angle of a triangle is smaller than the corresponding exterior angle.	30	26	34
11.	It is possible to construct a circle passing through any three points.	42	43	41
12.	The altitude of a triangle may lie outside of the triangle.	38	29	47

[4] Based upon actual responses—not including omissions.

13. If the diameter of a circle is perpendicular to a chord, it bisects the chord.	19[5]	11	22
14. Diagonals of a quadrilateral bisect each other.	64	55	30
15. The vertex of a central angle is located on the circumference.	25	11	31
16. All angles inscribed in semicircles are right angles.	40[6]	35	46
17. A cylinder has congruent bases.	32	27	38
18. The angles opposite unequal sides of a triangle are unequal.	17	11	28
19. A parallelogram possesses opposite angles which are equal	10	7	18
20. A polygon has as many vertices as sides.	39	37	45
21. The areas of two triangles having equal bases are to each other as their altitudes.	36	30	41
22. A prism has a volume equal to the product of its base and altitude.	53[7]	56	46
23. The sum of the two acute angles of a right triangle is equal to one right angle.	13	12	20
24. A segment of a circle is bounded by an arc and two radii.	78	85	75
25. Figures having the same size are said to be equivalent.	40[8]	45	29
26. In any proportion the product of the means is equal to the product of the extremes.	31[9]	14	41

Interpretation of Results

The results presented in the table are neither lengthy nor complicated. Interpretation of the results is consequently left largely to the reader. However, it is well to keep in mind the fact that the subjects were hastened in their reactions to the items of the test by the time limit normal to the administration of this kind of test for its usual purposes; also the fact that some guessing at the truth or falsity of items doubtlessly occurred, although the subjects had been given directions not to guess. To what extent these opposing sets of factors tend to cancel the effect of each other out it is, of course, impossible to determine.

In judging the virtues of the particular type of study represented here, recognition should be given to the fact that many institutions have given and are giving tests which are made to yield only the total scores needed for student classification and which might also be made to yield data concerning accomplishment on specific items of knowledge, the extent of common misconceptions, etc. Such supplementary use of test results has, of course, its limitations as well as its advantages.

[5] From 96% to 100% responded to items corresponding to 1–13.
[6] Between 90% and 95% responded to items corresponding to 14–16.
[7] From 80% to 89% responded to items corresponding to 17–22.
[8] From 75% to 79% responded to items corresponding to 23–25.
[9] The item corresponding to this statement was responded to by 68% of the subjects.

A SCIENTIFIC ASSEMBLY PROGRAM

WONDERS OF SCIENCE

MILTON BABITZ
Red Bluff Union High School, Red Bluff, California

One of the most pleasant tasks which a teacher may assign himself is the planning and production of a school assembly program which will idealize, and even somewhat glorify the subject field in which his teaching interests lie. Too often pupils in the high school have a very barren picture of the courses which they should be eagerly awaiting. Prompted by the thought that much good could come of an assembly program aimed at selling the science department to the student-body, the writer cautiously sounded out his chemistry students and obtained a picture of enthusiasm which made further planning imperative. The script, detailed below, represents the cooperative effort of youthful enthusiasm which willingly gave many an afternoon of free time, all with the understanding that regular class work would go on, while they planned their contribution.

In presenting the script, there is no desire to offer a stereotyped format which is essentially the formula for a successful production. Rather it is expected that individual experiences will contribute to the enrichment and expansion of the materials, to meet varied needs.

WONDERS OF SCIENCE

SPEAKER. It is our pleasure to present to you a show based on the wonders of modern chemistry. The knowledge of chemistry has grown through hundreds of years. Our first workers in this field were the alchemists. These scientists were seeking to prepare a magic stone, which would turn all things into gold. Of course they never found it, but they have handed to us a desire for the magic of chemistry.

CUE 1. We first present the Magic Wand. Will you have it white, or red, or white, or red. This could go on for ever.

The speaker has spaced her remarks to coincide with the experimenter, now occupying the stage, who is alternately decolorizing and coloring a phenolphthalein-water mixture by using a hollowed rod which is loaded at one end with sodium hydroxide, and at the other with tartaric acid.

After the alchemist came men who were seeking to find and understand the truth. For example one day our friend, Mr. Newton, went walking and an apple fell on his head. He wanted to know why.

CUE 2. What would he have done if he had seen this . . . ? Up they go and then down they go, and then up again. Why? Well you guess.

A solution containing sodium carbonate and sulfuric acid in a tall container is liberating carbon dioxide. Into this is dropped moth balls which have been previously dampened and rolled in sodium bicarbonate. They will then exhibit the properties emphasized by the speaker.

Time marches on. Since 1900 our scientists have begun to explain the reasons for the things we see and do. Why does a nail rust? Of what is your food made? Of what is water composed?

CUE 3. By the way do you have any water at your table? I would like a drink please. . . . Thank you. (Expter) "Are you all through? Guess I'll have some too. If you don't want any more I'll throw the rest away." (Speaker) "Oh, Oh, what did I drink?"

The experimenter has thrown the remaining drops of water onto a pea sized lump of sodium, covered with ammonium chloride for smoke effects. After a few sizzling sounds the sodium ignites from the burning hydrogen and will create a mild explosion of small particles of burning sodium.

Man has advanced only as he found better and better control over nature. Today with amazing accuracy we can predict the time and place of such things as eclipses, weather changes, and even comets. The experiment which you are now about to see will demonstrate how accurate the scientist can be.

CUE 4. Now that the two solutions are mixed, I will count to exactly 25, and at that moment the reaction will go off. 1, 2, 3, . . . , 25.

The experimenter has mixed solutions of starch, sulfurous acid, and iodic acid. The competing oxidation-reduction reactions may be timed so as to liberate free iodine at the desired moment.

The chemist of today has completely established man's independence of nature for the beautiful colors which make life so much more interesting. Once man journeyed to far away lands in search of valuable dyes. Today we prepare them in the laboratory, giving endless variety, at a price that all can afford. With incredible ease he can produce or erase colors at will.

CUE 5. For example the solution in the bottle is a deep purple, but as we pour it into the apparently empty container, the loss of color is at once noticeable.

The experimenter has poured a large bottle of dilute permanganate into a large container of sulfur dioxide gas.

CUE 5. (*cont.*) Here again we start with a purple mixture. A

drop of this, and a drop of that, and the color's gone.

The experimenter has added a drop of concentrated sulfuric acid and several drops of hypo to a dilute permanganate solution.

CUE 5. (*cont.*) If you do not care for a plain white, we can color it a light yellow, or a red, or a blue.

The experimenter has dipped a strip of white cloth into a ferric chloride solution, then into a potassium sulphocyanate solution, and finally into a ferrocyanide solution.

CUE 5. (*cont.*) How about an ordinary black and white color change? You can readily see that the paper is white on both sides. Now into the tank, and it's white on that side, and black on the other. That's an example of the chemistry of photography. In our science department you will find many opportunities to understand the chemistry of color.

The experimenter has exposed both sides of a sheet of photographic printing paper to the audience, then immersed it in concentrated developer, after which it is again exposed to the audience.

CUE 6. In these troubled times we are greatly concerned with national defense. However we should have no trouble meeting the challenge when our scientists can produce evidence of our democracy as easily as this.

The exptr. is spraying, with ferric chloride, a cardboard which has been previously treated with ferrocyanide, sulphocyanate, and tannic acid, in appropriate stripes and portions so as to result in the production of an American Flag, complete with staff, as the ferric chloride reacts.

The world is made of many things. Through chemistry man has patiently triumphed over nature's stumbling blocks. Though chemistry can be fun, its greatest aim is service to man.

CUE 7. Maybe you've wondered where the movies get all of their smoke? It's easy if you have the right chemicals.

The experimenter has a pump running which is forcing a draft of air over bottles of concentrated ammonia and hydrochloric acid. As the two streams of air meet, the smoke fumes are pronounced.

CUE 8. At this time I think it would be a good idea if we had some music. There's a good record on the phonograph. Let's play it. In the past few years one of the most popular scientific toys, which has made good, is the photo-electric cell. By interrupting the beam of light, the listener can turn the music on and off, as he pleases.

The experimenter has set the apparatus into operation, interrupting the loudspeaker circuit through which the phonograph is playing. Also he can cut off the speaker's microphone to create an interesting diversion, while the speaker says,

Just like conducting your own orchestra, isn't it? Don't you wish you could control your radio as easily as this?

Experimenter turns off phonograph.

Today the photoelectric cell performs hundreds of jobs. It is no longer a mere toy. It opens doors, closes windows, checks the weather, relays newspaper pictures, sorts fruit, and can even be made to match thread and cloth.

CUE 9. Here is the chemist at play! Today the scientist has improved on the smoker. Not only can he blow smoke rings, but he'll guarantee a perfect one each time. Don't try this one yourself, the gas is poisonous!

The experimenter has previously started a reaction forming phosphine gas which is liberated under water, and ignites spontaneously to form smoke rings as it strikes the air. It is important to adequately spotlight this experiment, avoid drafts, use a downhill delivery tube.

We are going to demonstrate that man is nothing more than a bundle of electricity, all mixed in just the right proportion.

CUE 10. Neon tubes are common nowadays, but how many of you can turn them on and off with your finger? Any color, round or long.

One experimenter holds an induction coil in his right hand while lighting a neon tube, held by an assistant, with his left hand. The same treatment is accorded a mercury tube. Other experimenters now join hands in a line with neon tube at one extreme, induction coil at the other, the high voltage being passed through all to light the tube.

Most people wouldn't take any chances on having an electric current pass through them, but our scientists aren't afraid. Now it's one, now two, now three, and four, even five. Will six work? Well done fellows.

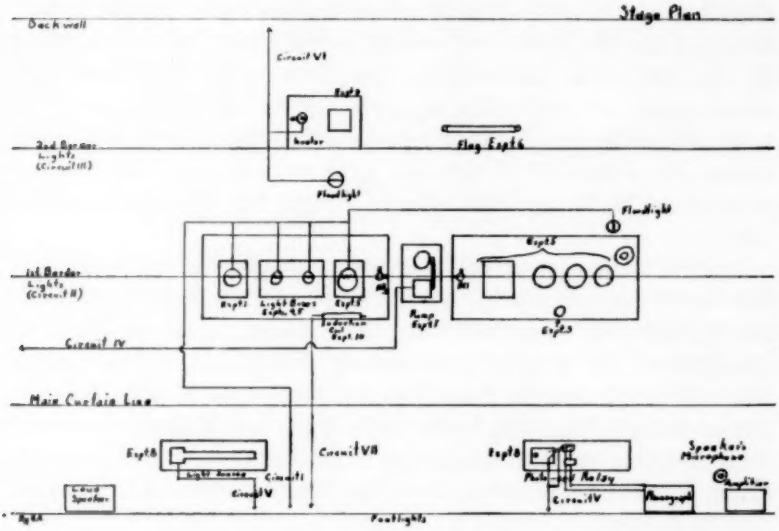
(*Curtains slowly close on group in stage center.*)

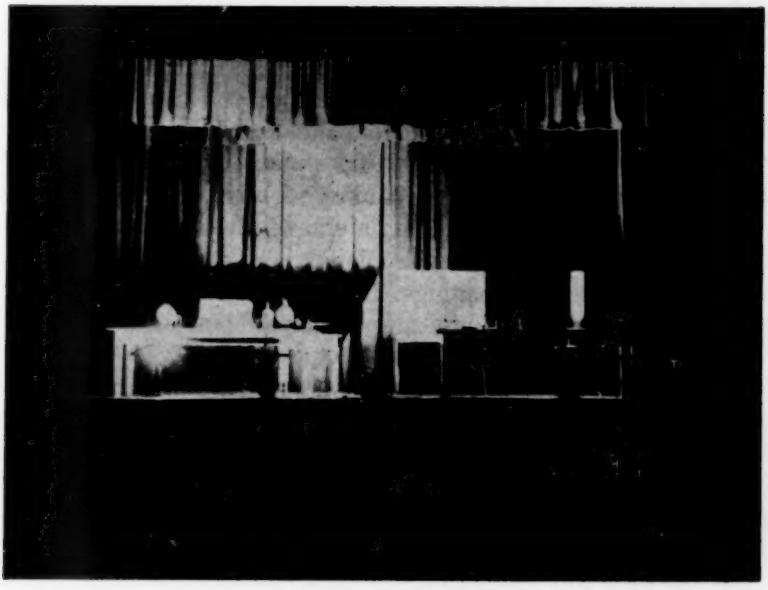
So you see, our science department has tried to show you the highlights of what makes science interesting. These exhibits were of the more spectacular type, but today all around you, if you look you will see other examples of chemical wonders. Stockings from coal, air, and water, rubber from natural gas, cloth woven from sand, and dresses from milk.

. . . . . .

As has been judged from grateful comments, the effectiveness of the presentation lies more with the staging and lighting of the stage action rather than with the script. To provide adequate lighting and yet maintain an aura of surprise through the

avoidance of glaring brilliance presents an interesting problem which can be readily solved by the judicious use of many extension cords, and whatever top (or border) lights and footlights





your stage may afford. The following diagram represents a suggested arrangement of equipment and lights which will usually not exceed the facilities of a small high school stage. The stage for which the plan was used had footlights operating from two switches which controlled alternate lamps, front border lights, and back border lights, each set of border lights being controlled by two switches. In addition two floor plugs were available which could be controlled by switches on the main panel. In addition to the regular lights installed in the above units, four spotlights of the 150 W reflector type were in use. Also a No. 1 photoflood bulb provided a light source for the photoelectric cell.

During the entire production, two red lights in the front border burned continuously. By reference to the diagram, the following lighting directions may be readily visualized for each experiment. For Expt. 1, use circuit I only. Expt. 2, circuit I only. Expt. 3, circuits I and II at the start and then all lights out as sodium begins to burn. Expt. 4, circuit I. Expt. 5, circuit I for first two parts, then change to circuit II for last two parts. Expt. 6, circuit III only. Expt. 7, circuit IV and II. Expt. 8, circuit V. Expt. 9, circuit VI. Expt. 10, circuit VII.

Between each two experiments all stage lights were off until the experimenter had taken his position. Precautions must be taken to insure that those experiments which require time for heating (by electric heater) are given ample time. Undoubtedly it is a wise step to have a student undertake control of the entire lighting problem from the outset, so that you can always rely upon his knowledge of the control panel and lighting circuits.

For those experiments which take place in glass containers, illumination from the bottom is most effective. For this purpose light boxes were constructed in a simple manner. Round holes were cut in the usual size of apple box and spotlights mounted directly beneath the openings. The diameter of the hole was so chosen as to leave adequate support for the beaker or glass container.

Varying stage facilities will of course determine ultimate arrangements. Let it suffice to say that lighting presents the most important issue, since it will be the key to the success of the program. In planning ahead for such an undertaking, one should expect to use six weeks before declaring the finished product.

If the program seems to invite opportunities for longer hours

of work, it all justifies itself in the renewed interest which it lends, and the thrilling enthusiasm with which pupils will look forward to their courses in science.

REFERENCE. An adequate description of the chemical experiments used in this program will be found in the splendid article by A. H. Struble, SCHOOL SCIENCE AND MATHEMATICS, May 1940, Pp. 418–426.

EDDY CURRENTS DEMONSTRATION

F. W. MOODY
Cleveland High School, St. Louis, Missouri

This assembly comprises three features.

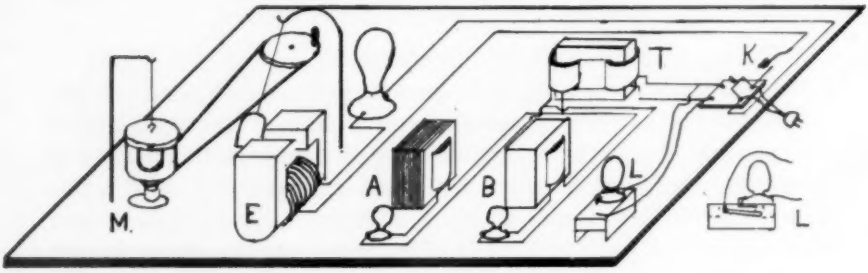
The first is a rotating U-shaped magnet, *M*, supported in an upright position. The supporting rod is free to turn and is belted to a wheel with a handle permitting the magnet to be rotated rapidly. Above the magnet is a circular copper disk with a rim like a cover, supported at its middle point by a rubber band serving as a spring to hold it in its zero position. There is just enough clearance so the magnet may rotate free from the disk, but the eddy currents set up in the disk, cause it to be dragged around in the direction of rotation as in some speedometers.

The second feature consists of an electromagnet, *E*, between the poles of which a copper plate is free to swing. A large lamp in the magnet circuit serves as a resistance. If the plate is set swinging and contact key, *K*, is pressed, closing the magnet circuit, there is an immediate decrease in the vibration due to the action of eddy currents in the plate.

The third feature comprises two induction coils, *A* and *B* of unique type. *A* was prepared from an audio frequency transformer by removing the coils and replacing them by a coil wound from larger wire, No. 30. *B* was prepared by cutting from an iron slab, a solid iron core of exactly the same size as the laminated core of *A*. Another coil for *B* was wound with exactly the same number of turns as that in *A*. Both coils are connected to the secondary of a step down transformer, *T*, and in the circuit of each is inserted a three volt flashlight lamp. Another small lamp, a 110 volt Christmas tree type, *L*, connected directly to the line, is mounted on top of a fiber box made to fit on the top of *A* or B, and having a small thermostat mounted below the lamp base and inserted in the lamp circuit. End supports hold the box up so that the thermostat just clears the iron core.

When the switch is thrown, starting the currents in the two coils, the two small lamps glow, but B is brighter than A, showing a sronger current in B, an evidence that coil B is consuming the more power.

When L is set on top of core B for a half minute the heat developed in the core causes the thermostat to close thus making lamp L glow. But when L is placed on core A, lamp L stops glowing due to the opening of the thermostat, proving core A, laminated, runs cooler and consumes less energy than B, due to the absence of eddy currents in the laminated core.



Three circuits demonstrating the effect of eddy currents.

Transformer T was made from another audio frequency transformer. The secondary was removed and a secondary of few turns and larger wire was added making it a step down transformer. The thermostat came out of a dime store blinker. The rotating magnet came from a wrecked radio speaker.

NEW SUPER-LIQUID STATE FOUND

A new super-liquid state, in which the substance is much more fluid than it was originally, was found to occur in certain liquid films one molecule in thickness just before solidifying.

The discovery was made by Drs. William D. Harkins, Lyle E. Cope.and and George E. Boyd of the University of Chicago, and was announced by them in a paper presented at the Chicago meeting of the American Physical Society.

This is of course the opposite of the usual behavior of liquids in solidifying, which generally become more viscous (less liquid) as the freezing point is approached.

The substances which showed this peculiar behavior were three forms of the higher alcohols which have high freezing points. They were particularly chosen because they have long, chain-like molecules like those of lubricating oils.

The investigation is of importance in studying the behavior of lubricants, paints and cleaners, Dr. Harkins stated, and will be continued.

A MATHEMATICS PROGRAM WITH AN EMPHASIS ON GENERAL EDUCATION*

HAROLD FAWCETT
Ohio State University, Columbus

Within the last year or so I have had the opportunity of visiting a number of teachers at work in their classrooms and I should like the privilege of reporting to you some of my reflections on one of these observations. When I entered the room shortly after the beginning of a class period I found 27 eighth grade students busily engaged in planning how they might actually compute the height of the flag pole located in the school yard and serving as a tangible illustration of a line perpendicular to the horizontal plane. While the discussion gave no clue concerning the origin of this problem I learned later that the teacher had consciously guided these 27 young people to a realization of the importance and usefulness of indirect measurement in modern life. She had asked for suggestions concerning problems to which the techniques of indirect measurement might be applied and among the numerous problems thus defined was the one then being studied.

The use of similar triangles had evidently been agreed upon as the general method to be used and while I missed any discussion which may have occurred in selecting that particular technique I did hear a most interesting discussion concerning such important points as: "What data do we need? How shall these data be secured? What measuring devices are necessary? How accurate should our measurements be? What is the best plan for recording these data?" All these points were thoughtfully considered and before the ringing of the inevitable bell which brought the period to an end the class had been organized into 5 groups and plans had been made so that on the following day the needed data could be obtained. Many of the students wanted to make the necessary measurements right away and asked the teacher if she would be willing to get them excused from their next class for this purpose. She was unwilling to do that but she did suggest to all the students that each of them should estimate the height of the flag pole and asked that these estimates be submitted at the beginning of the next class period.

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* Read before the Senior High School Section of the Central Association of Science and Mathematics Teachers, Nov. 22, 1941.

I left that situation just as interested as any of the students and determined that my plans for the following day would have to be changed so that I might continue my observation. On my return I found the students actively at work gathering the needed data. The effective manner in which each of the five groups, working independently of each other, carried out their responsibilities reflected the careful planning of the preceding day and within 20 minutes all the students were in their classroom using the data thus secured to check the estimate each of them had made. These estimates had been arranged on the board in a ferquency distribution, the range being from 35 feet to 150 feet, and the students worked with a very definite purpose as they studied the implications of the data they had gathered. What would these data reveal? Which of the estimates was nearest the actual height of the pole? Since 65 feet occurred more frequently than any other estimate, is that likely to be the most reliable? All the students seemed eager to have these questions answered and as they worked with the available data the teacher moved about the room offering a suggestion here, a word of encouragement there and helping those who seemed most in need of guidance.

When the students finally discovered that the height of the pole was approximately 68 feet it is probably correct to say that their major purpose was achieved. The teacher, however, had additional purposes in mind and questions concerning the noticeable variability in the results obtained led to a most profitable discussion concerning such important but frequently neglected points as the reliability of the data, the possible sources of error, the degree of precision desirable in a problem of this sort, the relative error and the idea that measurements are approximations.

Now it may be that I have used altogether too much of the time at my disposal for the purpose of reporting on this experience and, in fact, it is undoubtedly true that many of you are wondering why I should have made any such report at all. Am I not charged with the responsibility of discussing a mathematical program with an emphasis on general education and what has the height of a flag pole to do with that topic? Nothing, as far as I can see and yet the situation which I have so inadequately described emphasizes values which, in my humble judgment, are essential in any educational program dedicated to the development of citizens who know how to deal intelligently with the

problems of modern life. To know the height of any particular flag pole is relatively unimportant but to know what it means to define a problem, to recognize the factors that are pertinent to its solution, to gather the needed data, to examine the relations between these data and to draw valid conclusions is to know how to participate effectively in solving the problems which of necessity confront every citizen of a democracy. While the responsibility for developing these values rests with no one teacher or group of teachers, it is my opinion that mathematics may be effectively used as a means to throw the entire problem solving process into sharp relief. That is precisely what the teacher of these 27 young people was doing and, in my judgment, it is what you and I should be doing in our respective classrooms if we are to make our most effective contribution to the achievement of the broad purposes for which the secondary school was established.

There are, however, certain important aspects related to this "problem solving process" which call for special consideration and for which teachers of mathematics should assume major responsibility. The solution of most problems, for example, calls for some understanding of the language of number and one of the obligations of our profession is to provide a program which makes it next to impossible for the graduates of our secondary schools to be quantitatively illiterate. The alphabet of number is just as important in dealing intelligently with the problems of modern life as the alphabet of letters. It was needed by the students in their effort to determine the height of the flag pole and it will be increasingly needed by them as they face the responsibilities of citizenship.

While there may once have been a time when the use of large numbers was the special prerogative of the mathematician, the scientist and the astronomer, that time has long since passed and today the ordinary layman, if he would vote intelligently, must be able to think in terms of billions. Even this ability may prove to be inadequate, for as long as Congress remains in session we may at any time be forced to think of quantity in terms of the "googols" and "googolplexes" of Prof. Kasner. The extension of the number concept from the whole numbers of primitive man to the transfinite numbers of the 20th century is a monument to the creativeness of the human mind and while it is not proposed that the students in our secondary school should understand this entire development, it is proposed that they

should understand it to the extent of their varying needs and abilities and in any given situation the needed emphasis should be determined by the teacher and students.

A second important concept which calls for emphasis in any mathematics program is the nature of measurement. The height of the flag pole could not be computed without the needed data and in securing these data it was necessary for the students to make use of measuring instruments. What factors should be taken into consideration in selecting the instruments to be used? To what degree of precision shall the measurements be made? How many significant figures should be used in expressing the measured values? What are the sources of error which affect the reliability of the data? These are important questions and if anyone is to think effectively concerning problems involving measurement he should be well acquainted with such fundamental aspects of this concept as precision, accuracy, relative error, significant figures, and rounding off as well as the fundamental notion that at best all measurements are approximate.

Nor should he be ignorant of the arbitrary character of the so-called standard units. These units have no inherent validity in themselves. They are the creation of the people who use them and their so-called validity depends entirely on the agreement of these people as to their usefulness. It is a far cry from the digit, the palm and the span of less precise times to the almost unbelievable accuracy now made possible through the use of the cosmic standard. But even in this modern age we still find reflections of the crude units of earlier days in such expressions as "a pinch of salt," "a stone's throw$_1$" and it was only a short time ago that I heard a distinguished Ohio State University professor ask the waitress to bring him another "squirt of cream" for his coffee. In fact, a tourist who recently inquired the distance to a certain town was informed that it was "nine antique shops straight ahead," which well illustrates the importance, not to speak of the convenience, of being familiar with the arbitrary character of measuring units.

When the students selected the data needed for computing the height of the flag pole they were thinking relationally. They gathered the data which they considered pertinent to the solution of their problem and by recognizing certain well defined relations between these data they were able to determine the implied conclusions. One can not deal intelligently with *any* problem until he recognizes the nature of the relationships be-

tween the factors involved and the concept of relationship is one which should receive continued emphasis from the first grade through the twelfth. Mathematics has been defined as the science of necessary relations and mathematical content may well be used to illustrate the control which one has over a situation when he controls the relation between the variables involved. From the simple number relations of the elementary school to the more complex relations of the later grades there is abundant opportunity for student experience in organizing data so that existing relations may be discovered. The graph, the table of values and the formula are means by which relations can be expressed and the educated citizen of today should be familiar with each of these three types of symbolism. The concept of relationship should also be extended to include elementary statistical notions for the language of statistics is rapidly becoming the language of the educated layman.

The estimate of each of the 27 young people concerning the height of the flag pole was a sort of hypothesis to be proved or disproved by the results of the investigation. In this particular case the desired conclusion was reached by interpreting the data secured through a series of measurements which is a commonly used method for arriving at conclusions. The students believed that the answer they obtained was the "right" answer and a check with the blueprint in the principal's office supported their belief. They were convinced that the height of the flag pole was approximately 68 feet even though they recognized possible sources of error in the data from which this conclusion was derived.

But there are other aspects of proof with which all potential citizens should be familiar and the concept of proof is another concept which should receive continued emphasis from the first grade through the twelfth. The nature of the authority accepted by a boy or girl of seven is of a very different sort than the authority accepted by the same child when seventeen, as every parent knows. To what changing sources do our young people look for the authority which guides them in making judgments? What kind of evidence are they willing to accept in arriving at important decisions? Do they understand the far-reaching significance of definition? Are they acquainted with the role of assumptions in the field of logical thinking and are they able to detect the implicit assumptions behind the many conclusions they are pressed to accept? These are important ideas and they

suggest outcomes toward the achievement of which the study of mathematics can make a distinct contribution, but it will do this only when the student learns to think of mathematics as a system of ideas rather than a set of isolated and discrete skills.

From the first grade through the twelfth I would extend and enrich the meaning of these four important concepts—number, measurement, relationship and proof—by providing the kinds of experiences which call for the use of these concepts in problem solving. To the greatest possible extent, these problems should have the tang of reality to the students and I consider it highly important that these young people get as much experience as possible in defining problems about which they are concerned and in gathering the data needed for their solution.

I would by no means eliminate all use of the attractive texts which are now available but I would use them as good sources of problem material for which the authors have provided the needed data. I would encourage the students to raise questions concerning the adequacy and reliability of these data as well as how they might have been secured. I would *not* use a text as a sort of mathematical bible which provides the intellectual laws by which all people must think. These so-called laws were not passed by some mathematical congress and they are not rules to be memorized. They represent the synthesis of many ideas in the evolution of mathematical thought and this synthesis should not be and can not be *given* to any one. As a teacher of mathematics, however, I *can* give the students an opportunity to do the sort of thinking which leads to a recognition of important mathematical principles, but the synthesizing must be done by the students themselves.

In such a program the operational techniques of mathematics are placed in their proper perspective. They are no longer the beginning and the end of mathematics instruction but become the means by which the operations implied by these fundamental concepts are performed. Nor should the student ever be required to operate with symbols whose meaning is not entirely clear to him. If a student does not really understand the ideas represented by the symbols 3, 4, 7, +, and =, he can repeat $3+4=7$ until a new world is born where perhaps $3+4$ will not equal 7 and it will have just as much meaning for him as if he were intoning the proposition that $\alpha+\beta=\gamma$. The symbols of mathematics represent ideas. They are used because of the economy of thought they make possible but to manipulate these

symbols without an understanding of the ideas they symbolize is a false and costly economy.

With these concepts as a basis I would build a continuous program extending from the first grade through the twelfth and I would make this program a requirement for all students. I am not thinking only of those young people whose promise of achievement in the field of mathematics is especially inviting, for my responsibility does not end with them. I am thinking of all the students who move through the classrooms of our secondary schools and in this paper I am considering the nature of a program in mathematics which has potential promise of making a genuine contribution to the education of every one of these young people. I would not for a moment belittle the importance of the values served through a comprehensive knowledge of mathematical facts but I would also point out that a relatively small number of the 130,000,000 people in the United States have experienced whatever satisfaction there may be in knowing how to factor the difference of two squares or how to prove that the medians of a triangle are concurrent. It is also true that the great majority of these people will never be faced with the necessity of analyzing the evidence presented in support of a mathematical theorem but it is just as true that no thoughtful citizen of a democracy can avoid the necessity of analyzing the factors which are important in the great variety of problems he is called upon to solve.

In the long history of human experience there has probably never been a time when the ability to deal intelligently with the problems of democratic citizenship was more to be desired than at present and unfortunately problems of this sort are not limited to those whom inheritance has favored with an intelligence quotient of more than 110. They come to the intellectually rich and poor alike and as teachers of mathematics we have a responsibility for improving the problem solving ability of all our people if we would be faithful to the obligations of our profession. It is my opinion that these responsibilities will be more fully met if the emphases I have suggested should become the basis of a course in "Mathematics for all laymen."

If you do not get your journal regularly notify Business Manager W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.

THE EXHIBIT AS A SUPPLEMENTARY METHOD: IV—SULFANILAMIDE

HAROLD J. ABRAHAMS
Central High School, Philadelphia, Pennsylvania

Scientific observations and advances have long had news value. Indeed, some discoveries have received so much publicity as to have added words to the vocabulary of the most ordinary citizen. Every once in a while, there appears a contribution of such great noteworthiness as to merit recognition and emphasis by the science teacher. This recognition and emphasis serves at once a two-fold purpose. It not only accomplishes a useful educational end, but also shows effectively the direct connection between the school and the world outside. In this way, students are left with the important idea that the subject matter of chemistry, as, indeed, of the entire curriculum, is highly practical and of real value.

The drug sulfanilamide had been making frequent headlines in the news and was therefore selected as a subject for correlation between the outside world and the work of the school. An exhibit (see Plate 1)[1] to show the method of preparation of this useful drug was set up as follows:

Upon a low platform, at the rear of a museum-case were placed specimens of bituminous coal, wood, sulfur, table salt, air, and water. From the coal and the wood, a red and a green ribbon led off respectively to retorts supported by ring stands and clamps. One retort was half filled with powdered coal, the other with saw-dust, and under each retort was placed a bunsen burner and hose. A small sign near the first retort read "Destructive Distillation of Bituminous or Soft Coal," and a sign at the second retort identified that process as the "Destructive Distillation of Wood." Near the first retort labelled specimens of ammonia, benzene, aniline, carbolic acid, and naphthalene were exhibited as typical by-products obtained from coal. Near the second retort specimens of wood alcohol, acetone, and acetic acid were similarly shown. From the sulfur and air, yellow ribbons ran down to a specimen of sulfur trioxide, and from the carbon and iron electrodes of a partitioned glass cell for the electrolysis of sodium chloride solution, blue ribbons led to a specimen of hydrogen chloride. These two specimens, sulfur

[1] Photograph courtesy of Mr. Mark H. Hagmann of the Mathematics Department, Simon Gratz High School. Philadelphia, Pa.

trioxide and hydrogen chloride, had a large *plus* sign between them and a large *arrow* after them, followed by a specimen of chlorosulfonic acid.

A red ribbon led from the specimen of aniline already mentioned to a similar one placed in the foreground and a green ribbon led likewise from the specimen of acetic acid to a similar specimen at the front. The specimens of aniline and acetic acid had a large *plus* sign between them and an *arrow* after them, pointing to a specimen of acetanilide. A blue ribbon connected the rear specimen of chlorosulfonic acid with a similar one placed next to the acetanilide. Again a *plus* sign was placed between these two bottles with an *arrow* after them, followed by

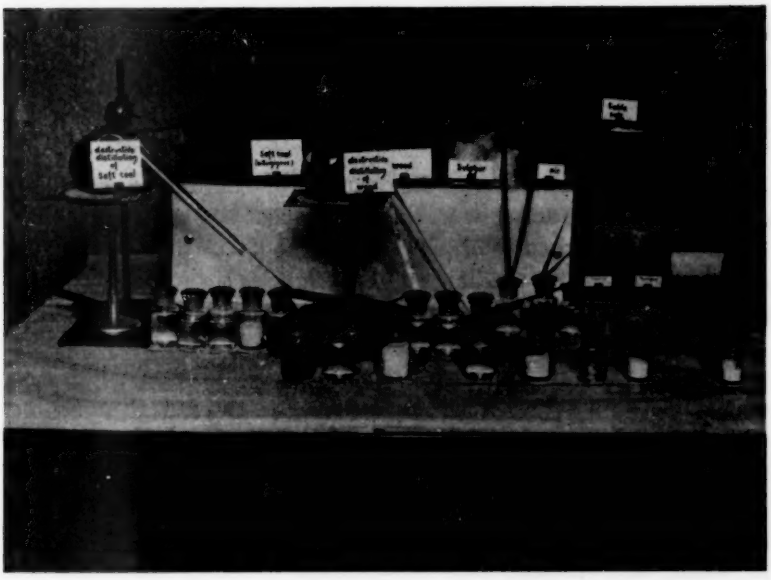

Plate 1. Sulfanilamide produced from air, salt, water, and coal.

a specimen of para-acetaminobenzene sulfonyl chloride. After another *plus* sign came a specimen of ammonia gas and again an *arrow* followed by a bottle of para-acetaminosulfonamide. A *plus* sign, a "bottle of steam," an *arrow*, and a specimen of sulfanilamide completed the exhibit.

Thus, the raw materials and their treatment to produce the intermediates were shown in the rear of the exhibit, and the interaction of the latter to produce the finished drug was shown, all in one line and suitably labelled, at the front, as follows:

Aniline plus acetic acid yields acetanilide—($C_6H_5NH_2 + CH_3COOH \rightarrow C_6H_5NH.OCCH_3$); which, plus chlorosulfonic acid ($HOSO_2Cl$) yields para-acetaminobenzene sulfonyl chloride—$\left(C_6H_4\begin{smallmatrix}SO_2Cl\\NHOCCH_3\end{smallmatrix}\right)$; which, treated with ammonia (NH_3) produces para-acetaminosulfonamide—$\left(C_6H_4\begin{smallmatrix}SO_2NH_2\\NHOCCH_3\end{smallmatrix}\right)$; which, treated with steam produces sulfanilamide—$\left(C_6H_4\begin{smallmatrix}NH_2\\SO_2NH_2\end{smallmatrix}\right)$.

It is very likely that most persons, pausing to examine such an exhibit, will be left with the permanent impression that chemicals do not "come out of bottles," but are made by many painstaking processes from the most commonplace raw materials.

The following plaque was placed above the exhibit:

A New Gospel of Science

Here on display you see an example of the ingenuity of the chemist—that cunning worker of miracles. By what the untutored mind would call "black magic," the chemist has produced a new and powerful medicine, *Sulfanilamide*, from ordinary air, salt, water, and coal.

These four raw materials in the museum-case may just as readily be used to make the most destructive explosives and deadly poisonous gases used in horrible warfare. Can mankind afford to risk choosing between applying the results of science for the welfare of all, or employing them for the wholesale devastation of much of humanity and all it holds dear? Let us recall the wise words of Poor Richard, "Goodness without Knowledge is weak and feeble, but Knowledge without Goodness is dangerous."

It is not sufficient for man to discover and apply the marvels of science. Along with his knowledge, he must be fired by the loftiest of virtues—love of fellow man. Yet we see man using scientific invention for purposes that will amass him great wealth. He does not seem to realize that he is the steward of earthly wealth. He does not use it as becomes a noble nature, namely, for the benefit of his fellow man.

Men of science have never intended their life's labors to be employed for furthering the ends of one selfish man against another, nor even to advance the interests of any greedy state

against those of its neighbors. If scientists have any practical aims in pursuing their dearly loved studies, they intend their work to benefit all mankind, irrespective of race, color, or religion. What a hideous misuse an aggressive war-mad nation makes of chemical discoveries when it puts this knowledge to use for the expansion of its political powers!

Science was never meant to be the property of one man, one state, or one people. Its fruits belong to all, for the universal betterment of the world.

ARE YOU PLANNING TO RENOVATE YOUR SCIENCE LABORATORIES?

WILLIAM P. ELLIOTT
St. George's School, Newport, Rhode Island

Science teachers are at times faced with the extremely complex problem of an intelligent renovation of their science laboratories. This article deliberately evades what may often be justly termed the most difficult obstacle to surmount namely obtaining the necessary funds. It does deal with that much more fascinating and most assuredly equally difficult task of what to do with the money in order to attain classroom and laboratory conditions which are the most efficient for any given institution. To many it will appear that the mere obtaining of funds will automatically result in a science utopia but experience shows that difficult as it is to get the required money it is equally if not more difficult to properly dispense it.

Therefore let us immediately and nonchalantly hurdle the "obtaining of funds" barrier and assume that sufficient money is available to put the laboratories in a condition which has until now appeared as only a hazy mirage. Such things DO happen.

By reason of their chosen profession science teachers, together with all others who teach, are not, to speak simply, familiar with money in any considerable quantity. Furthermore science teachers as a group are not qualified to deal with such things as square feet per student, lighting arrangements, type of furniture, costs and the almost infinite number of other technical details which arise when renovation or construction is contemplated.

The task is further complicated by the fact that the individual science teacher is the only person who knows the difficulties and the requirements of his or her specific problem. It must be realized that familiarity with the problem is in this case almost invariably divorced from experience in the solution thereof. Unfortunately necessity requires that this science teacher assume the responsibility of planning, buying and installing and hence become experienced in the more practical aspects of the task.

The following suggestions are offered in an attempt to aid those fortunate teachers who have the "wherewithall" and are desirous of eluding both the trial and error and the "spend what we have and see what we get" methods.

1. Retain continually the fact that the science laboratory is of value in so far as it, (a) aids the student in learning and (b) aids the teacher in teaching. The above order is deliberate and of significant importance.

2. Be unsparing of time and energy in talking with teachers who have completed or are contemplating similar work. This is by far the most valuable source of information and encouragement. The variety of detail which is so intelligently and graciously contributed makes this a most inspiring and productive experience. The oportunity to examine the laboratories of other institutions and to talk with those who work in them is one which is all too often neglected by science teachers. It is advisable that one planning renovations restrict his search for information to institutions of approximately the same size as his own for the problem is considerably different in larger and smaller schools.

3. Realize that the most careful time schedule is rarely adhered to.

4. Plan for furniture which while primarily intended for a specific location and use is also possible of adaptation for other purposes and places.

5. As a preliminary step consult furniture and equipment dealers solely for the purpose of obtaining costs and suggestions. These dealers are an extremely useful source of information but are handicapped by the necessary desire to sell.

6. Investigate the advantages and disadvantages of fluorescent lighting. In all cases of fine work such as dissection and use of the microscope much may be gained by a careful placing of such lights.

7. Install all services such as AC and DC electricity, gas,

water, and compressed air in the floor. In this regard it is wise to use intelligent foresight and lay piping for all services even though immediate use of some is not possible.

8. Plan for a few left handed writing arms for those neglected and forgotten individuals who are destined to find eating and writing arrangements deliberately planned for their inconvenience throughout most of their lives.

9. Anticipate a lack of drawer space three years hence. The size of drawers requires a careful examination of equipment both on hand and planned for. The usual stock furniture is of necessity not adapted for any specific laboratory and much space can be saved by knowing what dimensions are actually needed.

10. Investigate carefully the comparative costs of metal and wood furniture. Climate is one element to be considered here for warped table tops in a damp climate present a continual problem.

11. Insist on some type of blower system in the chemistry laboratory to clear the noxious fumes. These should be installed on the student tables whenever possible and one hood for two students is usually sufficient. In this regard, a blower outlet over the main sink drain is extremely useful. So often the room is contaminated when the students are forced to empty gas generators into an open sink.

It is hoped that these suggestions will not induce any recipient of financial aid for his laboratories to conclude that preparation for renovation is in itself a life work. It is believed that the results will more than compensate for the considerable amount of preliminary planning involved and will also do much to lessen the all too frequent readjustments which are noted in many comparatively new laboratories.

SOUTHERN CONFERENCE ON AUDIO-VISUAL EDUCATION

Copies of the *Proceedings* of the Fifth Annual Southern Conference on Audio-Visual Education, which was held in Atlanta on November 13–15, 1941, are available for purchase at $1.00 each. Included in the *Proceedings* are the principal addresses given at the Conference, and complete stenographic transcripts of seven group forums which were conducted during the Conference by leading audio-visual educators. Orders and remittances should be sent to the Southern Conference on Audio-Visual Education, 223 Walton Street, N. W. Atlanta, Georgia. Postage is free on all orders which are accompanied by remittances.

ABILITIES OF UNIVERSITY STUDENTS IN FRESHMAN MATHEMATICS*

M. W. KELLER and D. R. SHREVE
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It is likely that all will agree that a large part of elementary algebra is devoted to the development of skills prerequisite to the study of more advanced courses. Also, due to the very nature of the material, the subject must have a relatively fixed sequence where each topic is dependent upon the preceding ones. This interdependence requires that the students have an adequate working knowledge of these fundamental skills for a successful continuation of their study of mathematics. This leads to the question—Where, in this sequence of topics, shall we start our college courses in mathematics?

There are several approaches to this problem which have been used extensively. Perhaps one of the most prevalent of these is to assume that the students have mastered and understand their high school mathematics. In addition it is assumed that they remember it or that it can be recalled incidentally as they proceed in their college course. From these assumptions the logical answer to the question is that the course should start where the high school course stopped.

But as scientists and mathematicians should we not ask—Are the assumptions valid? Dr. J. Wolfe in an article entitled *Mathematical Skills of College Freshmen in Topics Prerequisite to Trigonometry* published in the April 1941 issue of *The Mathematics Teacher* found evidence to indicate that these assumptions may not be valid. With regard to incidental learning I quote, "that for a significant number of students the incidental classroom treatment of prerequisite topics in the trigonometry course did not suffice to correct background deficiencies."

Another approach has been to assume that the students never knew or had forgotten practically all that they knew about high school algebra. Now the answer to the question is that the college course should start at or near the beginning of algebra. Under this arrangement the elementary part is usually covered rapidly since it is actually review. Again let us ask—Are the assumptions valid?

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* Read before the Junior College meeting of the Central Association of Science and Mathematics Teachers, Nov. 22, 1941.

There is a variation of these two plans which is being used by many universities and colleges at present. This plan assumes that some students are adequately prepared to start college mathematics while others are not. The next assumption is that the only way for the poorly prepared students to make up this deficiency is to take additional work in elementary algebra. With these assumptions the answer to our question is again apparent. The students should be sectioned according to preparation and ability. The poorly prepared should be placed in a course which devotes considerable study to the fundamentals of algebra while the adequately prepared can start approximately where their high school training stopped. It is obvious that this answer is based on safer assumptions.

There is another way to answer the question if you will assume, first, that it is possible to determine what elementary skills it is necessary for the students to know and have an adequate mastery of for the successful study of college mathematics, and, second, that it is possible to determine by a preliminary set of tests which of these skills the students do not have. The answer to the question now is to start with a specific review of those skills which the students do not know and then proceed with the regular college course. This, it seems to us, is not only a sensible approach to the problem but also the most economical one from the standpoint of the time required.

As a consequence of this belief an extensive testing program was undertaken in the fall of 1939 at Purdue University by the authors in collaboration with Dr. H. H. Remmers of the Division of Educational Reference. This program had several avowed aims. Two of these aims were (1) "To determine, as definitely as group tests will permit, what mathematical skills and abilities the entering freshmen have at their command," and (2) "To determine, by diagnostic testing and remedial measures, how these difficulties or disabilities can best be eliminated or minimized in both the high school and the university."

Although the actual experimental work is still in progress to determine if we do have a good answer to the question and therefore cannot be reported on at this time, we would like to discuss with you some of the findings from the preliminary testing program and point out where they suggest we start.

Let us first outline briefly how these tests were constructed. A careful study was made of the elementary skills which the students must use in the trigonometry and college algebra

courses as given at Purdue University. Numerous problems from the texts were analyzed to determine what specific skills were used. The problems used on the tests involved these skills and were, in the judgment of the makers, of the same degree of difficulty as those the students will actually encounter.

The students tested were those assigned to Dr. R. H. Downing and the authors by a non-selective method of enrollment during the first semester of each academic year. Thus no attempt was made to choose the group tested. Each year they represented approximately 20% of the freshmen enrolled in the beginning course in engineering mathematics. These students have had, except for a very few, a minimum of three years of high school mathematics. In the past three years we have given these tests to 557 students.

The tests were given at the beginning of the course. Also there was no previous announcement relative to the tests, so the students knew nothing about it in advance.

With these preliminary remarks let us look at some of the results. We must keep in mind that we are assuming that if a student can do a problem involving a certain skill he understands the operation and could therefore do other problems involving the same operations. During the first two years each test contained two problems which in the judgment of the makers involved the same operations and were of the same difficulty. In this way we had a partial check on this assumption. The correlation of these matched pairs of problems was over .9. This helps to verify our assumption. This year, because of the high reliability, only one problem of each pair was included.

These tests show that the students understand how to perform the fundamental operations with whole numbers and simple fractions. They are quite inaccurate in their calculations, however. About 20% cannot carry through the product $97.6 \times .0708$ without making a mistake. In very few cases is the error due to the inability to locate the decimal point correctly or to take into account the zeros in the multiplier. If the students are asked to do two problems of this type then 30% cannot get the correct answer to both. This problem brings up an interesting point. Although there were less than 1% who did not handle the multiplication by zero in this problem correctly there were 10% who could not multiply a number by zero. Thus this group perform such multiplications when they occur in a problem in a purely mechanical manner.

In division only 30% can give the answer to the problem, $0.68 \div 0.0079$, correct to one decimal. The trouble is not due to a lack of knowledge of how to divide or locate the decimal point. The students miss the problem because they have not been taught to "round off" an answer to the nearest correct figure or else it has not been sufficiently stressed. This seems to be the situation in spite of the emphasis that has been suggested should be placed upon the topic of approximate numbers.

Problems in percentage cause some trouble. If we ask, "What per cent of 20 is 9?", the response is as good or better than one would expect. Approximately 85% can give the correct answer. When the students are asked to write 2.7% as a decimal 80% can do this but only 60% can write the per cent as a fraction. The difficulty is apparently due to an uncertainty in the meaning of percentage for if the students are asked to write .007 as a fraction over 90% can do this.

About 50% remember how to extract square root.

It was found that about 25% cannot distribute the multiplication correctly if a parenthesis is preceded by a negative number. The product of two binomials was easier. Almost all could factor the difference of two squares or a quadratic trinomial providing they contained no common factor. Thus about 95% can factor expressions of the type $w^2 - 25x^2$ but only 47% can factor completely $3x - 27x^3$. They do not factor out the common factor $3x$ first. This is an extremely common type of error and therefore one kind of factoring which should receive more attention when the subject is taught.

Between 80% and 90% can multiply and divide algebraic fractions where it is not necessary to factor in order to simplify. When the students are given a problem such as

$$\frac{x^2+3x}{7-x} \cdot \frac{7+x}{x+3}$$

then only about 50% give the correct simplified answer. As teachers you will be interested in some of the things we found relative to problems of this kind. Improper cancellation by terms, strange as it may seem, is not nearly as frequent as failing to simplify the products by cancelling common factors. Also about 10% more students can do a problem such as

$$\frac{m+4}{m+3} \div \frac{m-5}{m+3}$$

correctly than do a problem such as

$$\frac{k+3}{7+k}\cdot\frac{7+k}{k-3}.$$

In this connection, the first time it is necessary in class discussion to divide by a fraction I ask the class how we perform such a division. The response is immediate and seems almost universal that we invert the divisor and multiply. Then I ask why we do this. The silence is now universal. Here we are dealing with fundamentals. Let's not keep the students in the dark.

Equations of the first degree in one variable which are of the ordinary type which students usually encounter are one thing which the students really know. This includes problems as difficult as

$$\frac{x+1}{3x-3}=\frac{2}{3}.$$

Problems of the form $1/4y=12$ caused the most trouble. About 25% cannot do this type.

Of the types of problems discussed thus far we believe that it could be assumed that most students have adequate knowledge of the correct procedure or that the difficulties are such that they can be taken care of as they are used providing the teacher knows what specific difficulties do exist. Let us next discuss some of the types of problems which a large percentage of the students could not do. These are therefore the things which the students do not understand because they have forgotten or never knew them. These topics should therefore, it seems to us, be a part of the present college course in mathematics. At least our data indicate that it is unwise to assume that the students know these operations and proceed with material that is dependent on this knowledge. Such a procedure is apt to lead to failures that might have been averted by a study of these topics. The work of Dr. Wolfe from which we quoted previously and the results we have obtained thus far in our program this year seem to verify this belief.

The fact that division by zero is an excluded operation caused the most difficulty. Thus about 1% gave the correct response to $7.9/0$ or $7.9\div 0$. The method of writing was therefore not a factor. About 24% gave the incorrect response infinity. Over 90%, however, knew the quotient of zero divided a number. Thus it is apparent that the mathematics teacher should discuss

what we mean by "quotient" and at the same time show the necessity for the exclusion of division by zero. Since 24% gave the incorrect response infinity it seems evident that some mathematics teachers have not clearly distinguished between division by zero and what happens to a quotient as the divisor approaches zero as a limit. Such concepts are essential to a clear understanding of some of the most fundamental principles of mathematics. It is therefore important that we get the students to think and differentiate correctly between these two ideas when we are dealing with things so fundamental in our subject. We believe a large portion of this misunderstanding might be eliminated if we would avoid writing $\tan 90° = \infty$. It seems that students do not grasp the meaning of this notation. As a matter of fact it is a notation that is not generally used in other parts of mathematics.

As all of you know from your experience, we found that students do not know very much about exponents and radicals. Apparently this is one of the most difficult topics for students. If this is true they certainly should not be given a large number of difficult problems which only serve one purpose; that is, to confuse them more. They distinguish well between $4a \cdot 3a^2$ and $4a(3a)^2$. About 90% can do simple powers such as 3^3 and $(.3)^3$, and radical problems such as

$$\sqrt{\frac{16}{81}}, \quad \sqrt{\frac{5}{9}}, \quad \text{and} \quad \left(\frac{\sqrt{5}}{3}\right)^2.$$

Problems such as

$$\left(\frac{2a^2}{c^3}\right)^3, \quad (\tfrac{1}{8})^{2/3},$$

and "write $2^{3/5}$ in radical form" are of about equal difficulty. Approximately 55% can do these problems. Half of the students know that $3°$ is equal to one. The same number can do $d^2 \cdot d^{-2}$. If you replace d in the preceding problem by a number and write the problem $8^2 \cdot 8^{-2}$ then only 40% can obtain the correct answer. For problems such as

$$\frac{2^2}{3^{-2}}, \quad (-2)^{-3}, \quad (-8)^{2/3}, \quad (2a^2)^{-3}, \quad (-b^{3m+2})^2, \quad z^m \div z^{m-1}, \quad 3\sqrt{8} - \sqrt{2},$$

and $2\sqrt{5} \cdot 3\sqrt{15}$ we found that 30% to 40% could give the correct answer. Less than 35% could rationalize the demoninator of fractions such as

$\frac{a-\sqrt{3}}{a+\sqrt{3}}$ and 25% could simplify $\sqrt{a^2-\left(\frac{a}{5}\right)^2}$.

The tests also reveal that although more than 85% of the students can add and subtract simple numerical fractions less than 40% can perform the same operations with simple algebraic fractions.

Probably the most discouraging evidence we found was that the students cannot solve quadratic equations in spite of all the time that is devoted to this topic. You must remember that these students have had at least three semesters of algebra in high school. It is therefore likely that this deficiency is due, for the most part, to forgetting, since we have found that the students attain a relatively high standard of achievement on tests covering quadratic equations immediately after they have studied the topic. We found that 56% can solve a quadratic equation which can be factored. If a quadratic equation is given in the form $(y+2)^2=49$ then about 10% more are lost in the following manner. Since $(y+2)^2=49$ it follows that $y+2=7$ and consequently $y=5$. Over 90% of those who obtain the correct answers to the problem expand the left member, collect and factor even though this problem is given in the form that one obtains if he solves the problem by the method of completing the square.

In problems of the type $b^2=36$ there are 80% who give only one solution $b=6$. Less than 25% can solve a problem which requires the use of the quadratic formula or the method of completing the square. If the solution by the formula involves the square root of a negative number then only about 15% can solve the problem.

Thus we see that although more than 90% can factor a quadratic trinomial less than 60% can solve a quadratic equation by factoring. Moreover among those who can solve the equations by factoring it appears evident that they do it mechanically. Otherwise why should only 20% recognize that the equation $b^2=36$ has two solutions? The fact that every quadratic equation has two solutions was not sufficiently emphasized so that the students remembered it. It is obvious that even though the quadratic formula was learned, it, too, has been forgotten by most of the students. From these results it would seem wise to give a thorough review of this topic. Also it should be kept in mind that although it is convenient at the time we study quadratic equations to know the quadratic formula

it is easily forgotten. The teacher should therefore make a definite effort to recall it to the students' minds when it is used in subsequent work.

An interesting example which shows that one cannot always anticipate what is most difficult for students without actually testing is illustrated by the two problems "Solve $a = \sqrt{x/b}$ for x," and "Solve $a = \sqrt{x/b}$ for b." Let us now propose two questions. Which problem is most difficult for the students? What per cent of the students would you expect to get each problem? If you are like the other teachers of mathematics of whom we have asked these questions your answer to the first question will be wrong. One problem is no more difficult than the other. Thus we found that those who knew that you should square both members of the equation in order to solve were also those who could solve the resulting equation for either letter. One-half of the students can solve these problems.

The purpose of this discussion has been twofold (1) To indicate those topics which the students have had previously which should be included in a college course in mathematics. (2) To point out which of these topics the students found most difficult, or remembered least well.

It is our belief that there is only one sure way to obtain these facts and that is by actually testing the students. This determined order of difficulty also offers a criterion for estimating the amount of time to give each topic. Thus the more difficult a topic is the more time it should receive, if its importance justifies this extra allotment of time. If we cannot give sufficient time to any given topic so that a large part of the students have a satisfactory knowledge of it then such topics should certainly be eliminated.

The students' errors on each type of problem should be analyzed so that we can anticipate what the more common difficulties of the students will be as they study a given topic. In this manner it should be possible to reduce the number of mistakes students make.

It seems to us that if the mortality in mathematics can be reduced *without lowering our standards* then it must be by some such approach as we are suggesting. Certainly the traditional approaches have not been fruitful. Perhaps you will say that it is not desirable to reduce the mortality. Perhaps only those who can dig it out for themselves should survive. Then again perhaps one of the reasons for the precarious position of mathematics in

our present curriculum is due to our utter indifference to this constantly high mortality. Each failure in mathematics is more apt to produce an enemy than a friend.

It is perhaps axiomatic that students like and will study subjects which they can do, yet which offer a challenge within the students' limitations of ability. Mathematics offers both for most university students if the instructor will approach the subject content intelligently. If the course is so arranged that the student can understand the material no further motivation is necessary. The satisfaction derived from being able to solve a problem is reward enough for most students. If it is not within the grasp of the student no amount of motivation or coercion will produce the desired result.

Let us therefore "build up" from what the students really know, devote study to a topic in proportion to its actual difficulty for the student, and present each new topic with a knowledge of the kinds of difficulties the student is going to have.

ADVANCES IN OPTICS AND PHOTOGRAPHY MAKE BIG TELESCOPES BIGGER

Recent advances in optics and photography have increased the efficiency of the 100–inch Mount Wilson reflector until it has now attained the speed expected of the 200–inch when plans for its construction began in 1928. This was revealed by Milton L. Humason of the Mount Wilson Observatory staff in a statement to the Astronomical Society of the Pacific.

But he added that these gains could also be applied to the 200–inch telescope so that astronomers may look forward to a corresponding increase in power of the Mount Palomar instrument over that originally planned. While they have been building a 200-inch, the astronomers are getting a 400-inch mirror in terms of light delivered by 1928 standards.

He cited as a striking example of these improved methods the fact that for the first time a photograph has been obtained showing the center of our stellar system, the vast nucleus of stars around which oure entire galaxy rotates. It is estimated that there are 800,000 stars per square degree upon the plate. The photograph was made possible by using plates sensitive to red light instead of blue. Red light is much more penetrating than blue, and thus easily pierces clouds of cosmic dust revealing stars thousands of light years away. Ordinary plates sensitive to blue light only would show stars but a few light years distant.

Mathematics is not the discoverer of laws, for it is not induction; neither is it the framer of theories, for it is not hypothesis; but it is the judge over both, and it is the arbiter to which each must refer its claims; and neither law can rule nor theory explain without the sanction of mathematics.- BENJAMIN PEIRCE

ARE GENERAL SCIENCE COURSES MEETING THE NEEDS OF THE HIGH SCHOOL STUDENT?*

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In discussing the subject of general science courses meeting the needs of the high school student I am afraid that I am treading on dangerous ground, especially so since a great majority of you are general science teachers, while I am a teacher of a specialized phase of science, namely zoology. However, I am interested in the subject from two points of view: (1) because I am employed in a teacher training institution which is annually sending people into the scientific field. It is part of my work to supervise a portion of the training of these people. It goes without saying that I am anxious to see that our students are well prepared for the job that is before them. (2) The freshmen who come to us all too frequently try to avoid the sciences and mathematics, when their programs of study are made out. There seems to be a fear of science courses—that they are too hard—that they will be unable to meet the requirements of the course—and with some there is an absolute dislike of the subjects.

Perhaps the attitude of the student may be due to the handing down of the old idea that a person who studies science must be brilliant and "a little bit queer." This was the attitude in the community where I graduated some few years back and I am sure that the idea is still prevalent because I recently ran across the same point of view in a graduate student in one of our big universities, who expressed his philosophy thus: "people expect us to be queer so I am not going to disappoint them."

Perhap's too the attitude of the student is governed by the fact that the courses taught in the high school sciences all too frequently are attempts of the teacher to duplicate his college courses on a high school level, without adapting his material to the needs and comprehension of the student. In my own field of specialization, I have seen teachers attempting to use the same outlines that they themselves have used in college. Some years back the dissection of the crawfish, earthworm, and grasshopper was abandoned in our own laboratories because we found that our graduates were attempting to use their college outlines in high school classes.

* Read before the General Science Section of the Central Association of Science and Mathematics Teachers, Nov. 21, 1941.

The teacher's preparation is often the reason for his failure to adapt the material to the student's needs. In Illinois it is possible for a person to teach general science with a minimum of sixteen semester hours. This includes certain requirements in chemistry, biology, health, etc. In our own college every student graduating would be able to qualify as a general science teacher by taking one course in botany or zoology in addition to the regular requirements for graduation. That teachers so trained often teach general science in the high schools is shown by the fact that every summer term we have post-graduates frantically trying to arrange for enough hours to prepare them to teach general science—and to help them hold their jobs. When a call comes into the Placements office of the college, it is generally for a teacher of biology, mathematics, chemistry, or physics. After the school officials are convinced that the applicant has the proper number of hours for one of these subjects, he then is told that he will be expected to teach general science also. In a questionnaire recently sent to general science teachers in the southern Illinois high schools, we found from their replies that the average teacher of this subject has approximately 57 semester hours in science. Of these eight hours are in botany, fifteen in chemistry, twelve in physics, thirteen in zoology, and nine in geography. Seventeen per cent of the teachers replying to the questionnaire had less than thirty semester hours in science and three teachers had below the minimum number of hours required by state law to teach the subject. It is interesting to note that in several instances that the teachers with the low number of hours in science have master's degrees, indicating that they have no intention of doing further work in science.

The highest number of semester hours in science reported by any teacher was 145—grouped as follows: general science 20; biology 5; zoology 65; botany 5; physics, 10; chemistry 40. Incidentally this person seems to know what he is doing if one can judge from the answers on his questionnaire.

Incidentally the matter of equipment is a serious one in most of our high schools. Even the Model Schools in our teacher training institutions often are poorly equipped in science. Perhaps we do not really understand the meaning of the word model and are like the woman who was told that she had a model husband. Upon looking up the word model in the dictionary, she found that the word meant—A small imitation of the real thing.

Training in the use of the scientific method should be the aim

of every science course—yet I sometimes wonder just how well we use the method in our own teaching. Too often the teacher is rushed with the great number of classes that he is to teach, plus extra-curricular activities so that he has little time to give to his students outside of class. In fact the scientific method in his courses often degenerates into students copying answers from the text into work-books, without ever having had the thrill of gathering all the evidence regarding the experiment and making his own conclusions regarding the experiment. Sometimes I wonder if the teacher is really to blame in this respect, because if he has a program of physics, biology, general science, hygiene, physical education, and coaching basket-ball—or if he has a program of four or five different subjects, starting in the morning at 7:45 and lasting until 4 P.M. with extra-curricular activities lasting for an hour after—he hardly has time to find out what the recitation for the next day is going to be—without giving attention to each student individually, to see if he is following through with the scientific method. The book is too often the final authority. Quite recently a young teacher complained to me about her students. They insisted on an assignment in the text-book and would read nothing else—neither would they attempt to gain information by interviewing workers in the fields that they were studying. It will be interesting to see how things in this class will turn out by the end of the year.

The scientific method is still competing with superstition and "post-hoc" reasoning. "It is still a common practice of man, so-called civilized man, to follow 'post-hoc' reasoning; that is, because one event may sometimes follow the principle of control, the principle of experiment. 'Post-hoc' reasoning is one of a the commonest sins against the scientific method, and we still see it occasionally in science; for example, modern physicians."[1]

As an example of that type of thinking in some of our own people especially the people in the rural sections of the country —a man sees a hawk catch a chicken—therefore all hawks must be killed because hawks are chicken killers. The same principle is followed by some of our sportsmen's clubs, which offer bounties for dead hawks—any kind of hawks. The same kind of reasoning has been used in the case of the crow—although scientific evidence now seems to indicate that he is not quite as black as he has been painted.

Superstitions still prevail among the great majority of people.

[1] Carlson, A. J., 1941. "Science for Society." *The Science Teacher* 8:(3).

Frankly, I do not believe that there will ever come a time when superstition will not be in competition with the scientific method. I suspect that every one of you have some views that other people would consider a superstition—a slight fear of a black cat crossing your path—a feeling of dismay at seven years of bad luck when you break a mirror. Or perhaps you are like a friend of mine who said that he was not superstitious but that "he would just a leetle bit rather spit over his left shoulder than his right." A college teacher of mine, who held the M.D. degree, and whose hobby was gardening, constantly urged the students to forget all the superstitions concerning the human body—yet she very earnestly told me of what good potatoes she could raise by planting potatoes in the dark of the moon. That superstitions still hold sway is evidenced by the fact that I recently collected some 150 of them regarding animals from students in my classes. I am sure that I do not have all of them.

The use of the scientific method, requires, among other things, understandings of an ability to use theory. That we are failing to develop this ability is all too clear in our current practices where verbal statements of theories are frequently memorized without their being related to the actual things and observations to which they refer. This is illustrated not only in science but in other fields by emphasis in elementary classes on such distinctions, as for example between mass and weight, and differences in atomic structure, before the students have had experiences in which such distinctions are important or meaningful.

A second requisite for understanding of scientific method is understanding of conditions that must be fulfilled before a conclusion is substantiated. Too frequently, in common practice, students come to think of scientific generalizations as statements derived from human authority, or as in some current advertising, from a seer in a laboratory jacket.[2]

In getting closer to the question of the needs of the high school student in general science, we perhaps can do so by stating what we expect the student to gain from the study of the course. Not all teachers are agreed as to what the needs of the students in general science courses are. In reply to the question "What do you consider are the scientific needs of your students in general science, the following answers were given by high school science teachers:

A basic knowledge of some of the problems of science.
Development of the scientific method and attitude.
Preview of other scientific courses and desire to pursue them.
To become interested in things scientific.
To develop logical reasoning.

[2] Powers, S. R. 1939. "Teacher Education in Science." A preliminary statement for the sub-committee on Teacher Training. *Mimeographed.*

To gain the basic fundamentals for other courses that they may take in H. S. or College.
Acquaintance and understanding of science principles, as found and applied in the every day life of students as far as possible, since many drop out after the first year.
A knowledge of personal hygiene.
A knowledge of community hygiene and health.
A knowledge of scientific principles of all local problems, industries, and most of the major world industries.
Vocational guidance in all fields of Science.
Encouragement of science hobbies.
Biology, chemistry, and physics used in the every day life of pupils, in the class, for study.
Vocabulary, using materials for experiments, organization of material, sound, electricity, mechanics, chemistry, physiography, health, auto safety, bacteria, soils, requirements of plants and animals, etc.
A course to prepare and introduce—no other attempt made to define the needs.
Methods of conservation of natural resources.
An appreciation of the benefits of science.
To adjust the student to a laboratory subject.
A general knowledge of science for students who do not go on to school.
An appreciation of and a desire to learn more science for students who go on to college, practical health education rules and principles, and a practical application of general science to every day living.

The demand seems to be for the student to secure some practical knowledge, which will make his life fuller and more enjoyable.

The National Committee for developing a science program for science teaching has recently formulated nine fields in which a science program should yield desirable functional outcomes. They are: 1. Health; 2. Safety; 3. Recreation; 4. Maturing philosophy of life; 5. Intelligent consumership; 6. Orientation to work; 7. Maturing inter-personal relationships; 8. Conservation; 9. Responsible socio-economic action.

If we survey these nine fields in which desirable functional outcomes are expected it can be easily seen that they could be adapted into a practical course for the high school student in general science. This is the type of course that the high school superintendent is now demanding of his teachers. Statistics show that less than 10% of the high school students will go to college and about 90% will immediately take their places in the wage-earner field. Too often we have failed to take into consideration the fact that the greater majority of the students are not going to college and have catered to the 10% with more or less success as evidenced by the common complaint of college teachers who say: "I always teach them as if they have had no science courses at all. They show little evidence of it when they reach college."

This attitude of catering to 10% of the students and insisting that our science courses be disciplinary courses has often caused us to neglect the practicality of science with the result that more practical courses which should be taught by scientifically trained people have been introduced into the curriculum by teachers trained in other fields. Such courses as consumer education, safety education, etc. are examples of such material being taught by teachers trained in social science—yet the content of the major portion of these courses is science and should be subjected to the scientific method.

The sub-committee on needs of the National Committee for developing a science program for teaching has listed the following desirable outcomes in the fields previously mentioned as being especially important in the junior high school. This is the level at which general science is being given to the student and could very easily be incorporated into the course.

1. "Ability to judge a good restaurant, to plan meals supplying all body needs, to preserve foods, and to prepare them in ways to promote health." In achieving this functional outcome experiments might be devised in nutrition—using varying diets. This would involve a study of the different types of foods, the vitamins, caloric content of various foods and bacteria. Some high school teachers are achieving good results in this phase of the study using white rats as experimental animals. Some teachers would prefer to use the whole project as an individual study rather than as a class exercise.

2. "Habit of employing intelligent sanitary practices in personal care and group living." Studies of community health problems could very easily be used to achieve this outcome. The problem of sewage disposal, purification of water, immunization against diseases, and pasteurization of milk are projects which are always at hand for study. Field trips to sewage disposal plants, water plants, dairies, etc., bring out the practical phases of these topics. However, I find that in our southern Illinois high schools only about 50% of the teachers make use of these facilities. In one southern Illinois town there is an open sewer within two blocks of the courthouse and three sewers from the town open into the river—one near the "ole swimmin' hole" and two opposite the city park. Incidentally the city is taking its water supply from the same river, which also receives sewage waste from cities farther up the river. A splendid opportunity is present for a study of a community health problem—yet I am

told by students who come from that town that no mention is ever made of the subject at all.

Recently the students in a general science course in southern Illinois made a study of immunization among the students in the community which resulted in the following data: only 30% were immunized for small pox, 20% for scarlet fever, 30% for diphtheria, and 10% for typhoid. Evidently we have a long way to go in selling the idea of protection from disease by vaccination, immunization, etc.

There is a real need on the part of the student to achieve physical fitness depending upon adequate diets, sleep, outdoor life and medical advice, rather than upon cathartics, stimulants, patent medicines, home remedies, health fads, and exaggerated advertising claims. Many more functional outcomes in health could be added.

In the matter of safety the student needs to understand the conditions that make for falls, fire, explosions, poisonings, electric shocks, and other accidents in the home. This would involve the study of the principles of electricity, combusion, etc. Ability and caution in building, controlling and extinguishing open fires are also very important.

There is a great need for familiarity with driving regulations, together with civic concern for their observance and a desire to become a safe driver.

In recreation the students should acquire a tendency or ability to achieve satisfaction in some of the following fields. I quote only a few.

Gardening
Collecting nature poetry
Building simple radios
Building model airplanes and gliders
Keeping science scrapbooks and science files
Making amateur scientific collections
Active participation in science clubs, 4H clubs, scouts and campfire girls
Reading science books and magazines
Amateur weather recording and forecasting and collection of weather lore.

The skillful teacher is able to build up useful recreational projects in the science clubs. There is some element of competition in the science clubs which I am not sure belongs there—however it is a stimulating element which makes the student put forth his best effort. It would seem that interest in science clubs is growing, if we can draw any conclusions from the size and quality of the exhibits at the annual meetings of the Junior Academy

of Science. This year there was held on the campus of the Southern Illinois State Normal University a science field day which was attended by some 500 high school students. The day was spent in showing exhibits of the work of the students, high school as well as college. An inspiring talk by Dr. B. Smith Hopkins was a feature of the day. As a result of this meeting a Southern Academy of Science was organized. It is planned to have an annual meeting and field day, with the idea that we can gradually interest the great majority of the high schools of southern Illinois in the project. The Southern Illinois Academy of Science is affiliated with the State Junior Academy.

Time does not permit me to elaborate on the other fields in which desirable functional outcomes should be expected. However, I do not feel that it would be fitting to close this paper without mentioning the field of conservation. Very little attention has been given to conservation in the general science courses, yet it is a subject that is becoming ever increasingly important. It deserves far more attention than is now given it.

In this paper I have endeavored to show that courses in high school science should be practical, and that the student should acquire the scientific attitude in meeting personal and community problems. Perhaps the needs of the high school student in general science are too great to be included in a single year of work. Still in many schools there is a tendency to eliminate science as a required course, and in other schools only one year of general science is required. We are faced with the problem: Are general science courses meeting the needs of the student?

BONERS

Reported by CLIFFORD HOLLEY

The ball is weighed and dipped into the temperature of the furnace.

The heat energy required to melt or vaporize a substance appears in change of state of heat exchange.

The molecules of heat mix with the molecules of water, thus raising the temperature of the water.

Foods, that we are accustomed to eat cooked, seem very *incivilized* in their raw state.

When the pump handle is lowered the upper valve opens, thus letting out some of the partial vacuum.

The gondola in which Settle went to the stratosphere with all its instruments.

The *solubilities* of the two products are lead iodide and potassium nitrate.

There is nothing that will make one of the substances not mix *holy* with the other.

The atomic number of an element *refurs* to the number of planetary electrons in the atom.

TOMORROW'S PARENTS LOOK AT CANCER THROUGH EDUCATION

JOHN E. SHOOP
New Rochelle High School, New Rochelle, New York

In 1940 approximately 162,000 persons died in the United States from cancer, most of these persons falling in the age group of 40 to 70. But cancer is no respecter of age, for it attacks youth as well as those advanced in years. Cancer attacks most of the organs of the human body as well as organs of plants and other animals allied to man and his environment.

For many years the distribution of literature and the discussion of cancer has been frowned upon among the laity. This apparent lack of interest in the causes of cancer is the chief reason why cancer claims such a heavy toll of human lives. Because of this attitude doctors, clinics, hospitals, private research laboratories, cancer committees, etc., have been at a disadvantage in transmitting information about this serious disease. They are thus confronted with the problem of how best to bring the information to the attention of the public so that individuals suffering from minor cancers can be made aware of them and take precautionary measures to prevent a more vicious spread of the disease. Their problem also includes the education of the youth of America, who will be the parents of tomorrow, not to be afraid to inquire into the cause and effects of cancer, and to correct the erroneous ideas that have become prevalent regarding cancer. By acquainting the youth of today with pertinent facts about cancer we can in succeeding generations hope to reduce the death rate from that cause and substitute well and happy families where otherwise might be broken and shattered homes.

We, in Westchester County, are especially fortunate in having the Westchester County Cancer Committee located in Bronxville, New York, which dispenses information concerning cancer free of charge to all who seek it, and at great pains and effort tries to introduce this information through women's and men's clubs, societies and schools.

For the past four years the Biology Club of the New Rochelle High School has sponsored this Committee's exhibit containing models of cancerous tissues, charts, etc. Each year more than five hundred students and parents have seen this display. The topic has been discussed in the classes, literature has been dis-

tributed to be taken home, and after a week of the display an eminent physician, who spent much of his time in cancer research, addressed the group.

This year the Biology Club was asked by the Westchester Cancer Committee to present a radio skit over the local station at White Plains (WFAS) on the study of cancer. Eight students were chosen to represent the Club, and they worked up an original informational program to present to the audience of the air, entitled "Tomorrow's Parents Look at Cancer Through Education." In this way the radio audience could be made well aware of the fact that the study of cancer and information about its behavior need not be frowned upon, as the youth of today are only too anxious to learn all that they can about it. The program "Tomorrow's Parents Look at Cancer Through Education" follows:

TEACHER'S INTRODUCTION

"'Tis education forms the common mind,
Just as the twig is bent the tree's inclined."
Alexander Pope.

One of the purposes of education is to give the individual mental satisfaction by making him able to understand the forces of his environment and thus successfully to adjust himself to those changing forces. This adjustment can be made easier by guiding the individual through selected experiences in his school career. It is the selection of these essential experiences that motivate the formulators of curriculums to include certain subjects in the high school courses of study.

One of the subjects to which the child is introduced in his school career is biology. There has been much interest in biology shown among students in the New Rochelle High School, and from the present enrollment of 1900 students more than 1,000 have taken biology.

In teaching these pupils I have found them most interested in the great problems of Public Health such as control of tuberculosis, syphilis, cancer and other diseases. Students at this age are actively curious about what goes on in the adult world. Since Public Health is discussed so much in the newspapers, particularly in connection with our defense program, the attention of these young people has been directed to problems which affect the well-being of all. In discussing normal cell growth with students I have found it easy to introduce the sub-

ject of abnormal cell growth and in this way bring the attention to the great problem of cancer. I have found that there is no fear complex developed in the student, that on the contrary he is eager to learn about it, and that in many cases he takes the information home to his parents where it is freely discussed as a family problem.

From my own experience I am deeply in sympathy with the idea of the Westchester Cancer Committee that the adolescent period is the most receptive for information on cancer. At present we have in New Rochelle High School a Biology Club, the membership of which is composed of students of the biology classes and a ny other students interested in biological information. Through the cooperation of the Westchester Cancer Committee, for the past four years one feature of the program of this club has been a cancer exhibit, a talk by a physician, and circulation of literature concerning cancer. Consequently, many homes in New Rochelle have been reached through this active interest of the child.

I was much pleased when the Westchester Cancer Committee brought out its book *Youth Looks At Cancer*. This book, which has been offered to the high schools of Westchester County without cost as a part of the Educational Program of the Westchester Cancer Committee, has, I understand, been accepted, and is now being used in many of the schools throughout the county. We use it to good advantage in New Rochelle. I feel confident that the plan of graduating each year a large group of intelligent youngsters, well informed on the subject of cancer, will in time begin to lower the death rate here in Westchester County, and elsewhere in the country.

I have brought with me this afternoon several members of the Biology Club. Through the courtesy of Mrs. Betty Patterson, who is a member of the Educational Advisory Council of the Westchester Cancer Committee, I would like to introduce these young people to our radio audience and let you judge how well they are mastering the problem of learning about cancer.

These students have read the text *Youth Looks At Cancer*, have studied it in the classroom, and are much interested in this and other health problems. Each will introduce himself to you:

Betty Jane LeBlond, President of the biology Club
Hilda Wyner Marvin Grabel
Juliva Finamore Virginia Wetmore

Reinhart Schiff Caroline Schultz
Eugene Bilik

Now since these students have made an intensive study of cancer they will tell you in their own words what this study has meant to them.

TEACHER—Hilda, would you briefly review the book *Youth Looks At Cancer?*

HILDA—*Youth Looks At Cancer*, written by the Westchester Cancer Committee, is meant to lift the mists of cancer ignorance and to open the minds and eyes of people to its serious implications.

Cancer has been a dread disease ever since the times of the ancients. The Greeks gave it a name, later translated by the Romans into cancer, which means crab.

Other animals, insects, birds, and fishes also may develop this growth. All human beings, of every age, are liable to be attacked by cancer.

This disease is most common among middle-aged and old people. Today, with science highly developed, youth has a greater life expectancy than had those of previous generations. Unfortunately, however, long life brings with it a greater incidence of cancer.

For this reason youth must be ever on the alert and consider carefully the necessity for discovering cancer in its early stages since to date no cure has been found for cancer in an advanced stage.

Cancer can not be transmitted from one person to another by contact. It arises out of changes in the habits of certain cells of a person's own body. Most cells work together to produce certain effects; however, the cancer cell only multiplies and spreads as rapidly as possible.

One need not be alarmed by discovering a small lump in any part of the body, as it may be only a harmless tumor, but it is better to have a healthy fear and thus to investigate.

Experiments have been made with animals, but as yet medical men have not been able to discover the true origin of the disease.

However, some of the contributing factors have been found to be irritations by chemicals, heat, and friction. Age, skin color (white being more susceptible than brown), heredity, have also been considered. There is also an inherited insusceptibility to

cancer, but since there are so many other factors in cause, this is thought to be of merely minor importance.

There are many signs of cancer, of which pain, unhappily enough, is one of the last symptoms.

The conclusion is that cure lies only in applied knowledge.

TEACHER—Thank you, Hilda. Now Betty, will you tell us how the Club arouses interest of the student body in the problem of cancer?

BETTY—Four years ago the teachers of the Biology Department of the New Rochelle High School felt that there was a need for the dissemination of information outside of the classes on so vital a subject as biology which met with so much interest on the part of the students in the classroom. Accordingly, the Biology Club was formed to meet this need. Membership in the Biology Club is open to any student who is interested in the field of biology, regardless of whether he is enrolled in the biology course or not. At intervals of two weeks, meetings are held and the members have an opportunity to hear a speaker who is an expert in his field of interest. This year, for example, we have invited a taxidermist, a director of nursing, an herpetologist, and several medical men to speak about their work. These are only a few of the guest speakers we have had thus far.

For the past four years the Westchester Cancer Committee has been extremely cooperative in placing an exhibit of actual cancerous tissues in our school where not only members of the biology club but also parents, other students, and teachers may feel free to observe. Once a year, we also have the good fortune to have an eminent cancer specialist address our parents, friends and fellow pupils. In the biology classes a genuine intellectual curiosity on the part of the students fosters the initial interest in cancer and other diseases which we have been made to realize affect us so vitally.

I believe that much of the success of this year's biology club has been due to the splendid cooperation of the reportorial staff of our school paper, the *Huguenot Herald*. From time to time the various programs of the club appear in this paper so that those outside the club may know of our activities. It is in this way that many of our prospective members for the next year's biology club are being attracted.

TEACHER—Thank you, Betty. Perhaps, Reinhart, you could tell us about some current article that has appeared in the *Huguenot Herald*, the student publication of the New Rochelle High School.

REINHART—Though the benefits of classroom teaching are usually far-reaching, coming frequently long after exams and graduation are over, there are times when learning is immediately applicable. Such a time was last week.

The circumstances seemed not important—pamphlets on cancer were distributed in biology classes. One student took his home; his mother, reading of the symptoms, discovered she had cancer in an early stage. A few days later she was in the hospital for an operation. Today she has a chance to live. Yesterday, without that knowledge from the biology classroom, early death was inevitable.

There are times when learning is immediately applicable . . .

TEACHER—I am going to ask you, Virginia, how you feel about a young person's learning about these great health problems, particularly about cancer.

VIRGINIA—I think it is an excellent idea. None of us young people is probably going to develop cancer very soon, since cancer is a disease which usually affects people in middle life. We can, therefore, look at it much more objectively than our parents can, and being properly informed at this age when our minds are very receptive, I feel sure that should cancer attack us in later life we would be afraid *not* to go to the doctor instead of being afraid *to* go, as people are now.

TEACHER—That is true, Virginia, and I feel sure that many of you will transmit this attitude to members of your families who might be subject to the disease. Eugene, since we are discussing cancer, would you tell us what cancer really is?

EUGENE—Cancer is a disorderly growth of cells of our own tissues. In the social life of normal people, now and then a man goes mad. In the organic life of tissue, occasionally a cell behaves like such a madman. Substituting growth for work, it swiftly multiplies. It forms a shapeless mass that infiltrates its normal neighbors, forces its way beyond fixed boundaries, finds its way into blood vessels or canals of lymph, where minute fragments break off and are carried by the streams of the body to many and new locations, there to establish their crazy growth.

TEACHER—What have you learned, Reinhart, about the difference between a tumor and a cancer?

REINHART—All cancers are tumors, but not all tumors are cancer. Many tumors are benign and do no harm to the body, such as warts and moles.

TEACHER—What is the difference between a benign and a malignant tumor?

REINHART—Benign tumors are usually enclosed in a sac and no matter how large they grow they do not grow beyond the limits of the restraining membrane. Malignant tumors, however, act in a different way. They never stop growing and spread until they have taken the life of their host.

TEACHER—Is cancer a new problem to the medical profession, Juliva?

JULIVA—Cancer is one of the oldest of all the known diseases. The Ebers papyrus, written about 1550 B.C. describes a type of cancer very common today.

TEACHER—If cancer has been known to the medical profession so long, Caroline, why is it that there is at this time such an increase in the news items in our papers and on our radio about cancer?

CAROLINE—I think this is because cancer seems to be, at this time, on the increase through the whole world. It now ranks second as cause of death in the United States. Each year it kills more of our people than died in the World War. For this reason research doctors are constantly striving to find out what causes cancer and what would cure it, and societies like the Westchester Cancer Committee are trying to educate the public as to the symptoms of cancer.

TEACHER—What are the symptoms, Marvin?

MARVIN—Any lump in your breast or other part of your body, especially one which begins to grow or change in appearance. Any sore which does not heal in two weeks, particularly on the face or on the lip or in the mouth. Any unusual discharge or bleeding from any inner part of the body.

TEACHER—Has the medical profession been successful in finding the cause or cure for cancer, Hilda?

HILDA—While the cause for all cancer is still unknown, and there is no specific cure, doctors have learned more about the diagnosis and treatment of cancer in the last twenty years than in all the centuries that went before. It is believed that if all were used that is known about cancer by both patient and doctor, the death rate would rapidly fall.

TEACHER—Is it true, then, that cancer is often cured?

HILDA—Oh yes! Cancer in an early stage is often curable. Last year the American College of Surgeons produced the rec-

ords of 30,000 cases of cured cancer—persons living five years without recurrences.

TEACHER—How should cancer be treated, Virginia?

VIRGINIA—By surgery, x-rays, or radium, or a combination of the three in the earliest possible stages of the disease. No other form of treatment is of any value.

TEACHER—These appear to be expensive treatments. Eugene are there any places in Westchester County where people unable to pay can be treated?

EUGENE—Yes. We have a cancer clinic right here in the New Rochelle Hospital, and there are others throughout the County: At Grasslands Hospital, Valhalla; Mt. Vernon Hospital, Mt. Vernon; St. Agnes' Hospital, White Plains; St. John's Hospital, Yonkers; United Hospital, Port Chester; White Plains Hospital, White Plains; Yonkers General Hospital, Yonkers.

TEACHER—What does the Westchester Cancer Committee do for these clinics, Marvin?

MARVIN—The Westchester Cancer Committee advertises the holding of the clinics in the public press. It sends a nurse to the clinic and a historian, if desired. It does all the follow-up service requested of it by the clinic and pays for radium and x-ray treatments when necessary. It also provides transportation for patients to and from clinics.

TEACHER—What else does the Westchester Cancer Committee do to control cancer in Westchester County, Juliva?

JULIVA—It places exhibits throughout the county, has doctors speak before lay audiences, shows a very good picture on cancer, called "Choose to Live," and I think best of all has placed this text *Youth Looks At Cancer* before high school students like us.

TEACHER—Caroline, you wrote a very interesting term paper on the topic of cancer. Why did you select this topic?

CAROLINE—I selected this topic because it is one of the oldest of man's diseases about which an insufficient amount of information is known to science.

TEACHER—Where did you secure information for this paper?

CAROLINE—My information was secured from various places. Some of these sources were:

Health Department, Washington, D. C.
State Health Department, Albany, N. Y.
Westchester Cancer Committee, Bronxville, N. Y.
New York City Cancer Committee, Sponsor of the Cancer Exhibit at the World's Fair.

Another local source was the New Rochelle High School Library.

TEACHER—What phase of the disease interested you particularly?

CAROLINE—The treatment of cancer.

TEACHER—Why did you become interested in the treatment of cancer?

CAROLINE—The various treatments of cancer interested me very much because I would like to make this my life's work.

TEACHER—Did this information about cancer develop or allay fear in your mind?

CAROLINE—This information developed a fear at first in my mind because when I started I knew so very little, but as I studied this subject more thoroughly I put aside my fears as being very childish and not based on facts. The fear of cancer which the majority of the public has must be abolished before anything is done about the disease itself—so therefore I think more people should become acquainted with the actual facts.

TEACHER—How do you think this information which you acquired about cancer should be made available to other students?

CAROLINE—I think more leaflets or books such as *Youth Looks At Cancer* should be published for the use of the public. This book is written in such a way that the average individual without having a very scientific mind is able to understand its meaning. More lectures and illustrated talks should be given. Parents should also insist that the study of cancer and other well-known diseases be included in biology courses of study. Biology then might soon become a required subject in the public schools so that the education of the students will be a great asset in the prevention and control of such diseases as cancer.

TEACHER—Thank you, Caroline. Betty, can you tell us if cancer is a blood disease?

BETTY—No. The only part blood plays in cancer is that of a mechanical carrier of the cancer cells from one part of the patient's body to another.

TEACHER—Does cancer come from a single bruise, Virginia?

VIRGINIA—A type of cone cancer, known as sarcoma, may possibly be the result of a single severe injury. It is believed that a single injury to soft tissue, such as the breast, will not cause cancer to develop.

TEACHER—Is cancer hereditary in human beings, Eugene?

EUGENE—There are probably inherited tendencies to form cancer of different types. Since, however, the method of inheriting such tendencies is obscure and undoubtedly complex, the presence of cancer in one or both parents should be merely a cause of greater alertness in looking for and recognizing suspicious conditions on the part of the individual. There is no need of fear or of a fatalistic attitude. The facts do not justify them.

TEACHER—Hilda, are cancers in men and women different?

HILDA—There are no sex characteristics of cancer tissue. The same type of cancer may occur in both sexes.

TEACHER—Reinhart, is pain an early symptom of cancer?

REINHART—No, except in cancer of bone or nerve tissue. Pain usually is a late symptom, and when it occurs the growth is often far advanced.

TEACHER—Is there danger, Juliva, in watching a lump in the breast "to see what happens?"

JULIVA—Yes, a very grave danger. Time is the most important factor in the control of cancer and waiting "to see what happens" may permit a curable cancer to become incurable by spreading to other tissues.

TEACHER—Marvin, why are periodic examinations necessary to control cancer?

MARVIN—The earlier a cancer is treated the greater the chance of a cure. By the periodic examination cancer can be found in its early stages when there may be no signs or symptoms that call the patient's attention to his condition.

TEACHER—Caroline, can the spread of cancer be stopped or retarded temporarily?

CAROLINE—At times it can. Certain cancerous growths, hopeless from the standpoint of cure, may be controlled temporarily by radiation treatments. Sooner or later, however, these growths fail to respond to further treatment.

TEACHER—Can immunity to cancer be acquired, Virginia, as it can to diphtheria or typhoid fever?

VIRGINIA—Production of immunity is possible only in diseases caused by germs. Since cancer is not a germ, immunity cannot be developed against it.

TEACHER'S SUMMARY

Well, it seems to me that you students know a great deal more about cancer than your mothers and fathers do. I feel

confident that no students in our class are going to hide the symptoms of cancer and be afraid to go to the doctor. I am sure that they are going to give the doctor a chance to help them get well by going just as soon as any symptom appears. I feel that they are going to do better than that—that they are going to the doctor while they are well, and through a complete physical examination each year they will not only be sure that they have no cancer, but they will also be sure that they haven't any of the other diseases which can be so easily detected through these means.

I have great faith in these students, who are the parents of tomorrow. I think they are facing life bravely and fearlessly, and that through this type of education they are going to make their bodies better, and healthier than those of the generations of men before them were.

A DEVICE AS AN AID IN TEACHING THE IDEA OF TENS

HERBERT F. SPITZER
University Elementary School, Iowa City, Iowa

Begin with the concrete and gradually work toward the abstract is a rule that nearly every primary teacher accepts as one of the guides for her number program. Mere use of concrete materials such as blocks, sticks, and marbles for early counting, adding, and subtracting exercises will not of themselves, however, promote understanding of some phases of our number system. In fact unless certain precautions are taken, extensive use of objects in connection with counting may be a block in the way of the development of significant aspects of number.

The full significance of our numeration plan is often not well developed through use alone of counting of objects. That eleven is most conveniently thought of as a ten and a one and that thirty-four is three tens and four ones are obvious facts to students of arithmetic, but frequently the child who counts 34 blocks or desks fails to see any such convenient classifying as the use of tens affords. To the child 34 is probably just one more than 33, very much as 6 is one more than 5. No systematic form or scheme of bringing out relationships becomes a possession of the child merely by counting objects. He, of course, profits by such experiences, but instead of contributing to an understand-

ing of our number system, such experiences point toward the development of "model groups,"[1] a scheme man used before our present system was developed. If children are to see the fact that number-names in the series beyond nine signify not just larger groups of ones but instead a collection or collections of ones which can be handled as conveniently in thought as ones are handled, then the children must have experiences which will demonstrate this fact. Many people who have a good grasp of the idea of tens, the basis of our decimal system, attribute this understanding to discovery of the convenience that comes from grouping objects to be counted by 10's. Fortunately, modern methods of teaching are again emphasizing the grouping phase of counting. However, even when objects or marks are grouped by 10's, the collection idea is not very pronounced.

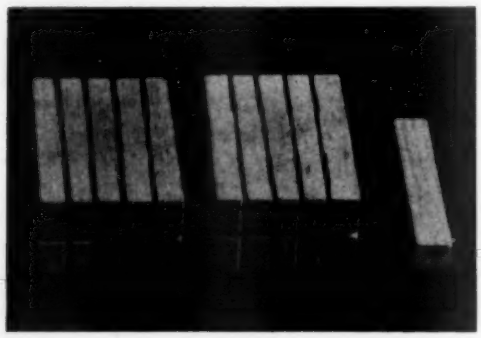

FIG. 1

Forty or fifty years ago the use of sticks tied in bundles of ten as an aid in teaching carrying and borrowing partially illustrated the collection idea. But because the bundles of sticks are not really entities, the collection idea is not adequately developed. The bundle still has ten individual sticks in it, and because it can be so easily changed to just individual sticks, emphasis on the collection idea is not complete.

In order to emphasize the collection or entity idea of the device, Lamborn[2] proposed the use of what he called a tens block. This was nothing more than a block which was ten times as large as the single blocks used. Lamborn's tens block had lines grooved on its surface to show the ten smaller blocks to which

[1] Wheat, H. G., *The Psychology and Teaching of Arithmetic*. D. C. Heath, 1937. Pp. 7–12.
[2] Lamborn, E. A. Greening, *Reason in Arithmetic*. Oxford at the Clarendon Press, 1930. Pp. 18–20.

it was equivalent. The writer has modified Lamborn's block by partially cutting out the smaller blocks yet leaving them joined in the center. (See figure 1.) At the Elementary School of the State University of Iowa these blocks have been found very useful in teaching the collection idea, in teaching borrowing and carrying, and in teaching the relationship or meaning of the number names above nine. A few procedures which illustrate the uses of the tens block are described below.

In order to demonstrate to them the superiority of grouping by tens, the children were asked to show what numbers like 21 meant. Since the children had had work in which the meaning of numbers was emphasized and because they had had an op-

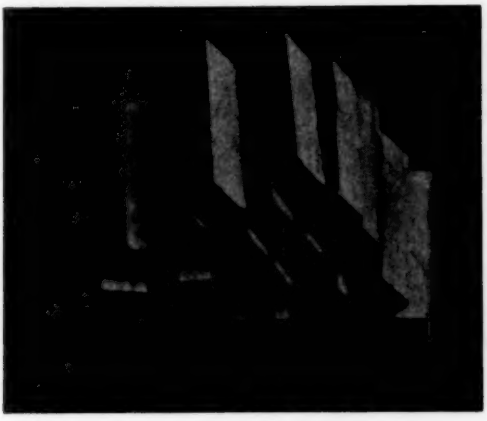

FIG. 2

portunity to play with the tens blocks, some suggested using two tens blocks and one ones block to show the meaning of 21. The presentation of 21 ones blocks was another proposal. (See figure 2.) Other children were asked to check the accuracy of the presentations. It was quite obvious that the checking of two tens blocks and one ones block was much easier than the checking of the 21 ones blocks. In answering the question, "Which is the better way to show 21?" there was unanimous agreement. Other numbers like 12, 44, and 73 were shown in the same way. Through this use of the tens blocks, the child saw that seventy-three meant seven tens and three ones, and saw better the relationship between numbers like the forties and eighties. Numbers illustrated in this way gave the children a tangible means of seeing the economy of grouping and also demonstrated

concretely how one standard group (10) can be used in getting an idea of the quantity represented. Thus, instead of having to build up meanings of many model groups, the child needs only one for all quantities less than a hundred.

In carrying and borrowing the advantage of using the tens block was more obvious. For example, in the addition of 28 and 14 the children saw that it would be far simpler to represent the sum with 4 tens blocks and 2 ones blocks than it was to use the original 3 tens blocks and the 12 ones blocks. The children really did with the blocks what we actually do with the figures. That is, they never presented more than nine ones but always substituted for ten ones its equivalent, one ten. This substituted or "carried" ten was then combined with the other tens. Where borrowing was involved, as in the problem involving 44–16, the children saw that after the 4 ones of the 44 were removed, additional ones would have to be secured. Previous work in substituting a tens block for ten ones blocks suggested the substituting of ten ones blocks for one of the tens blocks which represented forty.

The next procedure following the use of the tens blocks employed words instead of the blocks. For example, forty-four was written as four tens and four ones, or 4 tens and 4 ones. Finally the conventional 44 was used. The tens blocks, therefore, serves as an intermediate stage between the use of actual objects and the use of abstract symbols as well as emphasizes and illustrates important phases of the number system.

NEW 3000-WATT MERCURY VAPOR LAMP WILL BRIGHTEN DEFENSE FACTORIES

A new 3000-watt mercury vapor lamp, the largest of its type in the world, has been announced both by General Electric and Westinghouse.

General Electric believes that the new lamp will be a boon for the lighting of steel mills, foundries and other shops where large areas require a lofty mounting of the lights.

Westinghouse plans to use the lamp if possible for a new lighting of the torch of the Statue of Liberty.

The 3000-watt mercury lamp is a tubular light source 55 inches in length and a trifle over an inch in diameter. It is rated at 120,000 lumens, which is eight times more powerful than its nearest rival, a 400-watt mercury lamp, although it is only four times its length. The latter, previous world champion in its class, is today the chief source of illumination in many factories.

The new lamp gives twice as much light per watt as an incandescent lamp. The cost of using a single large unit, the companies point out, is considerably less than that of several smaller ones.

THE CONTENT OF HIGH SCHOOL PHYSICS*

E. BURDETTE CHRISMAN
Dayton High School, Dayton, Washington

An ever recurring criticism of education is that it lags behind the advancing front of knowledge and fails to coordinate with current social needs. What should be taught and what omitted is a question every teacher must decide each day he is in the class room. Objective data as to what phases of a particular subject matter field should receive special emphasis, are rare. Yet, even though these subject matter choices are crucial in the educational experience of the individual, the classroom teacher, often unaided, is responsible. It was with this in mind, that the question of the proper emphasis in the content of high school physics was approached.

The problem was attacked along three lines to arrive at something of the social usage of the divisions of physics; (1) analysis of newspaper articles for a year's period to determine what physics concepts and applications are being called to the attention of the public in general; (2) a survey of selected group opinion as to what should be taught, and the relative emphasis it should receive; (3) a survey of the articles recorded in the *Education Index* for 1930–40 to determine what "frontier thinkers" among the physicists are working upon. Data from these sources were combined and cast into graph form on the basis of the number of school weeks of work implied. This then was compared with results of a tabulation of the number of pages in two currently popular textbooks, to determine what shifts in emphasis, if any, were implied.

The newspaper used was the *Morning Oregonion*, published at Portland, Oregon, for the year 1939–40. Tabulation was made of only those references to physics concepts or applications that appeared in paragraph form. No regular advertising was counted. Certain items peculiar to the location of the newspaper were tabulated and considered separately in order not to color the results of the study as a whole. A total of 13,655 items were checked. These were then grouped in a frequency table in terms of the usual divisions of physics subject matter: mechanics, heat, light sound, and electricity. In addition the term "modern applications of physics" was used in this study to designate certain

* Condensation of a Master's thesis, State College of Washington, 1941.

items usually treated somewhat aside from the regular text book classification—automobiles, airplanes, and radio, principally. On the basis of frequency, this information was then translated into the number of school weeks implied, using 36 weeks as a school term. Provision was thus made for direct comparison of data with text book coverage.

TABLE I

Newspaper survey, expressed in terms of school weeks

Modern Applications	12.6 weeks
Mechanics	11.0
Sound	5.6
Heat	3.3
Electricity	1.9
Light	1.6

Three organizations from the community in which the study was made were selected for the group opinion survey. The Kiwanis Club, the American Association of University Women, and a Young Men's Club, corresponding to the Junior Chamber of Commerce. The total number of responses was fifty-nine. A check list of fifty-five items was used, based on student questions covering the main topics of high school physics. Data from the three groups were then averaged, and expressed in terms of school weeks, to provide comparison with the rest of the study.

TABLE II

Check List survey, expressed in school weeks

Mechanics	9.3 weeks
Modern Applications	7.7
Light	6.7
Electricity	6.5
Heat	3.0
Sound	2.8

The published articles, 214 in number, as listed by the *Education Index*, were considered in terms of the 1930–35 period, the 1935–40 period, and the full 1930–40 period, separately. The preponderance of articles were written on light. Electricity, sound, heat, motion, electronics, and mechanical apparatus follow in that order. Again the data were converted into the number of school weeks implied, according to the relative emphasis as derived from frequency of occurrence. In addition, to establish the standing of the authors in their fields, the names were

checked in *Who's Who* and *American Men of Science*. Seventy-five per cent were found listed in those sources.

TABLE III

Published Articles Survey, expressed in terms of school weeks

Mechanics	9.4 weeks
Electricity	8.8
Light	6.6
Modern Applications	5.7
Heat	3.0
Sound	2.5

It does not necessarily hold that the number of pages in a division of a text is a direct index of time spent in covering that division. However, on the basis of experience, a positive correlation was assumed. Such assumption makes possible a direct comparison with results from the "social usage," or "desirable emphasis" sources.

When the data from the surveys of the newspaper, published articles, and selected group opinion were averaged, expressed in terms of school weeks, and compared with the textbook survey the following table resulted:

TABLE IV

	Mech.	Mod. App.	Heat	Light	Sound	Elect.
Average	9.9	8.7	3.1	4.9	3.6	5.7 weeks
Texts	11.4	3.6	4.8	4.6	2.6	9.0 weeks

A striking feature of this tabulation is the closeness of agreement between the two. Only two marked deviations are apparent. Electricity is receiving 56% too much attention (9 weeks against approximately 6 desirable), and "modern applications of physics" is being accorded 57% too little time (3.6 against a desirable 8.7 weeks). The rest of the divisions agree, probably within a normal range of fluctuation in teaching, so are disregarded.

Much the same results are obtained when comparison is made with various combinations of the data obtained, thus lending additional support to the conclusions. Further analysis of the data reveals an indicated need of attention particularly on the subjects of the automobile, airplane and radio. As the study covers data only up to 1940, the present defense program does not color the results.

It is not to be inferred that the indicated over-emphasis on

electricity, and under-emphasis on automobiles, airplanes, and radio, are absolutely valid. Only to the extent that the brief study is an indication of need, is this true.

THE SLIDE RULE WATCH

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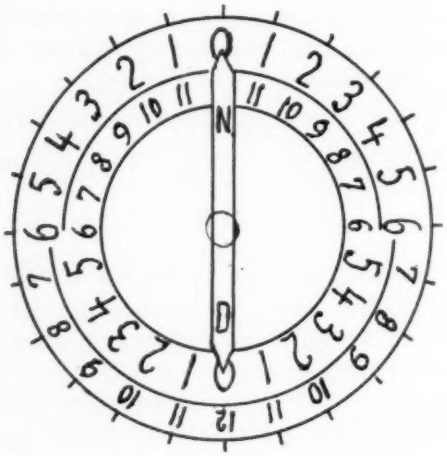
Louisville, Kentucky and University of Toledo, Toledo, Ohio

During the last few decades the slide rule has been recognized more and more as a very satisfactory tool for computations that require no greater degree of precision than that offered by a three place logarithm table. One imperfection of the instrument, however, that makes itself frequently felt, is the fact that it is of no aid in locating the decimal point of the result. Therefore, if the approximate magnitude of the latter is not known, the careful operator is compelled to carry out a brief mental computa-



tion or to take some kind of notes that will enable him to place the decimal point correctly. In order to eliminate the necessity for such procedures, a little apparatus has been developed which can be used in conjunction with any ordinary slide rule whose upper scales range from 1 to 100.

This apparatus, which may or may not be fastened permanently to the slide rule, essentially consists of a dial and a pointer. The dial is provided with two concentric scales while the pointer has two arms of unequal length, the longer one being marked

"*N*" and the shorter one bearing the letter "*D*." The numbering of the scales is seen from the accompanying picture which illustrates the zero position of the instrument. The rules for using the "slide rule watch" are as follows:

1. If in a factor of the numerator the decimal point is moved a certain number of places to the right (or left), arm "*N*" is moved the same number of divisions of the outer scale to the right (or left). If in a factor of the denominator the decimal point is moved a certain number of places to the right (or left), arm "*D*" is moved the same number of divisions of the inner scale to the right (or left).
2. If the factor 10 (or 100) is inserted in the numerator, arm "*N*" is moved one (or two) divisions of the outer scale to the right. If the factor 10 (or 100) is inserted in the denominator, arm "*D*" is moved one (or two) divisions of the inner scale to the right.
3. If in the base of a square the decimal point is moved a certain number of places, the pointer is moved twice the number of scale divisions. If in the radicand of a square root the decimal point is moved a certain number of places, the pointer is moved half the number of scale divisions. (Corresponding rules apply to cubes and cube roots).
4. At the end of the computation the pointer is turned back to the zero position. If in this operation arm "*N*" moves a certain number of scale divisions to the right (or left), the decimal point of the result is moved the same number of places to the right (or left).

In order to illustrate the use of the apparatus, a few examples may be given. In these examples the following symbols are employed: "*Bu*" for the upper scale of the board, "*Bl*" for the lower scale of the board, "*Su*" for the upper scale of the slide, "*Sl*" for the lower scale of the slide, and "*C*" for the cursor.

Example 1

$$x=\frac{182\times 0.17}{0.0375}$$

Slide Rule	*Watch*
Place C on 1.82 (Bl)	Move N 2 divisions to the left
Place 3.75 (Sl) under C	Move D 2 divisions to the right
Place C on 10 (Sl)	Move N 1 division to the right
Place 1 (Sl) under C	———
Place C on 1.7 (Sl)	Move N 1 division to the right

Read the result from Bl: 8.25	Turn N back to zero: 2 div. to the right
$x=825$	

Example 2

$$x=\frac{134.7^2\times 3.54\times 0.0087}{7650}$$

Slide Rule	*Watch*
Place C on 1.347 (Bl)	Move N 4 divisions to the left
Place 7.65 (Su) under C	Move D 3 divisions to the left
Place C on 35.4 (Su)	Move N 1 division to the right
Place 100 (Su) under C	Move D 2 divisions to the right
Place C on 87 (Su)	Move N 4 divisions to the right
Read the result from Bu:7.30	Turn N back to zero: 2 div. to the left
$x=0.0730$	

Example 3

$$x=\frac{48}{0.85}\sqrt{\frac{29}{3750}}$$

Slide Rule	*Watch*
Place C on 4.8 (Bl)	Move N 1 division to the left
Place 8.5 (Sl) under C	Move D 1 division to the right
Place C on 29 (Su)	———
Place 37.5 (Su) under C	Move D 1 division to the left
Place C on 10 (Sl)	Move N 1 division to the right
Read the result from Bl:4.97	N is on zero
$x=4.97$	

It is obvious that the steps employed in the above computations are not the only possible ones. However, no matter in which way the problems are solved, the apparatus described in this paper can always be used with success.

NEGRO HISTORY WEEK FEB. 8–15

The celebration of Negro History Week is sponsored by the Association for the Study of Negro Life and History which was founded by Carter G. Woodson in Chicago on September 9, 1915. He is still the executive of this organization. The purposes of the Association are to collect sociological and historical data, to publish books on Negro life and history, to promote the study of the Negro through clubs and schools, and to bring about harmony between the races by interpreting the one to the other.

THE FORTY-FIRST ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

RAY C. SOLIDAY, *Secretary*

SOME TWO THOUSAND members and guests attended the 1941 convention of the Central Association of Science and Mathematics Teachers at the Stevens Hotel in Chicago, November 20–22nd.

It was stated by many that the program was one of the best ever offered. Great credit and congratulations should go to President Metcalf, and to the other general officers, section officers and the numerous local committeemen under the leadership of Mr. Joseph Dickman, who worked throughout the year to secure outstanding talent for the program.

SCHOOL SCIENCE AND MATHEMATICS will print manuscripts of many of the speeches, as a service to those teachers who were unable to attend the convention. However, some items of the program were of such a nature that formal manuscripts could not be provided for publication. Among those who appeared on the general programs of the convention were: Professor Arthur Holley Compton, University of Chicago; Professor Ira Davis, University of Wisconsin; Miss Mary Potter, Racine, Wis. Public Schools; Professor C. A. Elvehjem, University of Wisconsin, and James Hillier of the RCA Research Laboratories.

Continuing a plan initiated last year at Cleveland, a luncheon meeting was sponsored by the Geography and Conservation groups. This was very well attended, and the program was highly profitable. It included a timely talk by Dr. G. Donald Hudson of Northwestern University, on "The Geographic Basis of Conservation," in which he traced the development of the conservation movement. He showed its beginning as a restriction of use of materials, but pointed out that conservation now is thought of in terms of controlled and directed usage of our resources for the most effective ultimate good.

THE FRIDAY MORNING GENERAL SESSION

The Convention program was opened by Professor Arthur Holley Compton, of the University of Chicago, who presented a scholarly and lucid address on the topic, "Application of Mathematics to Science." Professor Compton emphasized the importance of mathematics as a tool of great value in the development of man's thinking and in the expression of thoughts. Mathematics has developed as a result of the felt need of man for thinking in exact, concrete terms, especially in the need for expressing and recording measurements. "Measurement made a need for mathematics. Mathematics made measurement significant." Thus mathematics has become a tool, which, with logic, makes possible man's use of the scientific method of thinking. In following the scientific method of thinking, man attempts to keep his thoughts rigidly objective, to form deductions based upon a logical development of the known facts, and to check these deductions by the most complete and objective means at his disposal. In thinking scientifically man proposes many problems which mathematics can help to answer. In defining the exact place of mathematics in the sciences, Dr. Compton used many illustrations from his own field of physics. These showed mathematics as a means of facilitating the formation of logical deductions. The scientific theory of today is usually the result of a thinking process involving mathematics. Several notable examples of mathematical understandings preceding laboratory observations were given. Thus mathematics has proven useful in the expansion of man's thought

from the simple conception and expression of measurement to the complex thought processes of the scientific method. Dr. Compton closed his address by quoting from "The Ballad of Ryerson," by E. H. Lewis, which, in a way more appropriate than even Dr. Compton knew, perhaps, illustrated the importance of mathematics.

Professor Ira Davis of the University of Wisconsin, well-known to his audience as president of this Association in 1938, spoke on "Trends in Science Teaching." This paper will appear in full in the JOURNAL.

Miss Mary Potter of the Racine Public Schools, gave a companion paper on "Trends in Mathematics Teaching," in which she cleverly described modern methods of teaching as observed by a parent while visiting a school. The use of new types of practical apparatus and reference books, and the practical approach through shop and field problems was emphasized.

The intellectual menu of the 1941 program was well selected for its basic nutritional value, especially in vitamins. The contribution of Professor C. A. Elvehjem, distinguished vitamin authority from the University of Wisconsin, was of particular and timely interest.

After briefly and graphically presenting the early history of scientific discoveries showing the relationship of diet to health, he rapidly covered the further development of the field leading to the present definite knowledge of the functions of the various isolated vitamins. At the same time, he effectively explained the importance of controlled experimentation with various animal subjects both in diagnosis and assaying vitamin contribution and content. A few of the many significant statements he made follow. The words are not exactly his, but it is hoped that the meaning is the same:

One cannot give a single answer to the questions, "How Does the Scientist Study Vitamins?", because each is studied differently.

Knowledge about any one vitamin is the result of intensive work by many, not one.

Discoveries in apparently unrelated fields have brought about startling successes when interpreted as bearing on the same problem.

As late as 1914, pellagra was classed as a specific infectious disease.

Goldberger proved pellagra was caused by diet deficiency by producing it in pardon-offered "guinea pig" prisoners. He also produced a sort of dermatitis in rats similarly and cured it with yeast. This is now known to be due to riboflavin "g" in the yeast. It is further known that rats do not get pellagra and are therefore not satisfactory subjects in the study of that disease.

Experimentation with dogs was more successful. Lack of fresh meat caused "black tongue" similar to pellagra. Liver extract prepared for anemia cured both black tongue and pellagra. Nicotinic acid, discovered in 1867, was more or less neglected until 1930. Then work in Sweden and Germany in the apparently unrelated field of enzymes and co-enzymes in tissue respiration brought it to the attention of Professor Elvehjem, who began its use in diet studies.

Nicotinic acid proved negative with rats. It cured black tongue in dogs! It has cured thousands of cases of pellagra! Its lack causes a decrease in the co-enzymes in liver and muscle, resulting in pellagra. It accomplishes astounding recovery in as little as three days! Its use to prevent pellagra is more important than the cure.

Methods of assaying vitamin content must be specific for each, and are being improved. The present bacterial method of vitamin assay introduced six months ago has done as much as three years of dog assaying.

No one can predict what type of experiment will be most successful nor in what field the next important advance vital to vitamin knowledge may be made.

BIOLOGY SECTION

(Joint meeting with the Chicago Biology Round Table)

Presiding: Joseph W. Rhodes

This section program was designed to serve the varied needs and interests of those present. There were two numbers given by specialists in their particular fields, two numbers by classroom teachers who displayed actual specimens of work done by their students, and a report on teaching materials and equipment.

Mr. Kirk Stevenson, Schurz High School, Chicago, presented each teacher with a mimeographed booklet entitled *New Materials in Biology Teaching*. This booklet, compiled by Mr. Stevenson, gave a complete review of textbooks, manuals, workbooks, books for reference and general reading as well as bibliography of new apparatus and supplies. The report showed clearly the trend away from the purely scientific treatment of biology to the broader personal, social and economic aspects of the subject. The expressed purpose of many authors is to enable the student to more ably meet the problems of his everyday life and to become a better citizen, thus aiding in the preservation of our democratic way of life.

Professor Ralph Buchsbaum of the Zoology Department, University of Chicago, presented an illustrated lecture on *The Ecology of the Tropical Rain Forest of Panama*. By means of beautiful slides and moving pictures Dr. Buchsbaum pointed out that the never ending struggle for light among the great variety of trees, ferns, vines and fungi had eliminated all blooming plants and left only a few herbs in the forest where temperature remains fairly constant, but the rainfall in one day may equal that of six montns in the temperate zone. The competition for livelihood is also high among animals, thus explaining the many species but few individuals of each to be found, a great number of which are nocturnal.

The paper *The Vitamin Requirements of Different Species* presented by Professor C. A. Elvehjem of the Biochemistry Department, University of Wisconsin, stressed the nutritional differences of all living things. The organic growth factors found in vitamins are needed by every organism, but only through experiments can the kind and supply required be determined. For example, man and monkey alone need vitamin C added to their diet, all other animals being able to manufacture it. The problem ahead is to decide the character of the nutritional requirements of human beings and this must be done by working with monkeys since their diet is most closely related to man. Much work must be done and the technique of research improved to satisfactorily solve this problem.

Mr. I. P. Daniel, of Lake View High School, Chicago, presented an interesting exhibit of plaster casts poured from rubber molds designed and made by his biology students. Complete instructions for this activity were given showing that such a project, within the ability and price range of high school classes, would increase knowledge, skills, and technique and at the same time provide excellent illustrative materials.

That vocational biology has an opportunity today of making a patriotic appeal to aid National Defense through its teaching of gardening was shown by M. O. Lichtenwalter, of Lane Technical High School, Chicago. Both by lecture and printed outline Mr. Lichtenwalter gave practical suggestions about gardening at school with and without a greenhouse. As proof of his excellent results in such an activity he exhibited many plants and flowers in various stages of development.

Well over a hundred persons attended the meeting. The officers elected for the coming year are: Chairman—John C. Mayfield, University of Chicago; Vice-Chairman—Sarah C. Caldwell, Garfield High School.

Akron, Ohio; Secretary—Cecilia J. Lauby, Thornton Twp. High School, Harvey, Illinois.

SARAH C. CALDWELL, *Secretary*

CHEMISTRY SECTION

Presiding: Sherman R. Wilson

Report on the Work of the National Committee on Science Teaching

E. L. Massey, Supervisor, High School Sciences, Detroit, Michigan

In order that a really worth-while science program be developed for all levels of education from the kindergarten through the junior college, the Department of Science Instruction of the National Education Association made a request for funds which was granted by the General Assembly of the N.E.A. in 1938. The National Committee on Science Teaching was appointed in February, 1939, consisting of fourteen members, including representatives of the National Education Association and representatives of various established nation-wide organizations of scientists and science teachers. In addition there are over 200 consultants representing every state in the United States.

The first meeting was held in Cleveland, Ohio, February 23–24, 1939. Since that time there have been other meetings of the committee in Cleveland, Atlantic City, New York, Chicago, Milwaukee, San Francisco, and St. Louis.

The general committee has set up seven sub-committees as follows: Philosophy or Frame of Reference; Needs of Pupils; Teacher Training; Evaluation; Procedures; Materials; and Administration. The reports of these sub-committees have been criticized at the many meetings and then rewritten for each successive meeting.

Three sub-committees, Philosophy or Frame of Reference, Needs of Pupils, and Teacher Training, presented their final reports to the general committee at the Stevens Hotel, Chicago, on Oct. 9, 10, and 11, 1941. These reports are being rewritten in light of the criticisms and suggestions offered at this meeting and should be ready for publication within the next few weeks.

The other sub-committees have been gathering large quantities of information for their final reports. Future meetings will probably be meetings of individual sub-committees, bringing together materials which have been collected and preparing their final reports.

Mr. Massey stated that the reports of the three sub-committees which are now in their final form will be available in printed form in a short time. He then gave a preview of each report by reading the table of contents from each as given in its preliminary form. These tables of contents indicate that the reports should be read and studied by every science teacher in the country.

Election of Officers

Mr. Ray C. Soliday, Oak Park, Ill., gave the report of the nominating committee, and the election of officers resulted as follows: Chairman—Mr. J. C. Chiddix, Normal High School, Normal, Ill., Vice-Chairman—Mr. R. W. Woline, Shortridge High School, Indianapolis, Ind., Secretary—Mr. John O. Collins, East Technical High School, Cleveland, Ohio.

Vitamins and Minerals in Relation to National Health—H. B. Lewis, Professor of Biological Chemistry and Director of the College of Pharmacy, University of Michigan.

Professor Lewis stated that at least twenty-five per cent of the people in the United States do not have an adequate diet. This is true even though the people in the United States have a potential diet which is superior to

any other country in the world. Numerous surveys were quoted to support Professor Lewis's statement. The people who do not have an adequate diet are those who cannot afford to purchase the basic foods needed (financial reasons) and those people who have ample means but are unable to select the proper foods (inability to choose proper diet).

The American people have, and are, changing from rural people to city people. This change has caused the introduction of "fabricated" foods. Our sugar, for example, is at least ninety-nine and one-half per cent pure. Consequently, it cannot carry much, if any, other nutritional materials such as vitamins and minerals. Sugar consumption averages five and one-half ounces per capita per day. This amount provides one-fourth of the essential calories man needs but this sugar is used only as fuel.

Our cereals are refined until almost pure. In this refining process most of the minerals and vitamins are lost. Sugar and cereals provide two-thirds of the twenty-five hundred calories needed by man per day. Thus, one-third of the diet must bear the load of providing our minerals and vitamins.

Professor Lewis suggested that the nation's diet could be bettered by (1) making more effective use of natural products, (2) restoring some of the natural foods which are removed in the process of preparing the food for the market, and (3) fortifying certain foods with some of the essential food materials which were never present in that food but which could be added to the food easily.

A lively "question and answer" discussion followed Professor Lewis's talk. A short report like this cannot describe the interest that was shown in this talk.

What Good is Chemistry for Consumers? Mr. A.R. Moore, J. Sterling Morton High School, Cicero, Ill., Mr. Norvil Beeman, Oak Park-River Forest Twp. High School, Oak Park, Ill., and Mr. W. W. Kronsagen, Glenbard Twp. High School, Glen Ellyn, Ill.

These three teachers of chemistry presented a well-planned discussion of the developments of consumer chemistry as it is now being taught in some of our leading high schools. They considered the purposes of these courses, the criticisms frequently heard, and the strong features as stated by teachers prominent in the development of consumer chemistry courses. The members of the forum did excellently at presenting points of view representing different goals and types of students. Their presentations were followed by a spirited question and discussion period, with participation by most of those who were in attendance.

R. W. WOLINE, *Secretary*

ELEMENTARY SCIENCE SECTION

Presiding: Miss Mary Melrose

After the reading and approval of the minutes, the first number of the excellent program was presented by Mr. Glenn Blough, of the University of Chicago Elementry School, who conducted a most dynamic learning situation in sixth grade science. Under his guidance, the boys and girls from Sister M. Magdalene School explored the problem, "What is an electro-magnet and how does it work?"

The second number on the program was a description of a fifth-grade unit in conservation, given by Dwight K. Curtis of the State University of Iowa Elementary School, Iowa City. He laid before the assembly some ways of teaching conservation, as well as some of the difficulties which hamper conservation instruction. The lack of effective reading materials seems to be the greatest hindrance at present.

Miss Anna E. Burgess, principal of the Elementary Science Curriculum

School in Cleveland, Ohio, closed the program with a discussion of the services which a curriculum center school can render to the teachers in the school system which it serves.

Miss Mildred Fahy, chairman of the nominating committee, recommended the following officers for 1942.

Chairman: Dr. Paul E. Kambly, University of Iowa, Iowa City.

Vice-Chairman: Miss Anna E. Burgess, Principal of Miles Standish School, Cleveland, Ohio.

Secretary: Miss Illa Podendorf, Science Supervisor, Newton, Iowa.

At the Saturday morning session, Dr. Paul E. Kambly, the vice chairman, presided. He introduced a sixth-grade class with their teacher, Mrs. Bernadette V. Greig of Gage Park Elementary School, Chicago. Mrs. Greig presented a demonstration of an activity in measurement. This demonstration had been arranged by Dr. J. T. Johnson.

This activity became the first subject of the panel discussion which followed. On the panel were Dr. Herbert F. Spitzer, Principal of the University Elementary School, at the State University of Iowa, who acted as chairman, Mr. Dwight K. Curtis, also of the State University of Iowa Elementary School, Dr. J. T. Johnson, of Chicago Teachers College, and Miss Anna E. Burgess, Principal of Miles Standish School, Cleveland, Ohio. Members of the Audience also entered into the discussion of the questions presented. Dr. H. O. Gillet of The University of Chicago, who was in the audience, made several valuable contributions to the discussion.

ANNA E. BURGESS, *Secretary*

GENERAL SCIENCE SECTION

Presiding: Mr. H. A. Oetting

Mr. A. W. Henderson of Wood River, Illinois, presented a paper on "Visual Aid Program in Science at the East Alton-Wood River Community High School. Among the visual aids he included those for special fields of instruction: "photography, photo-engraving, microscopy, flat pictures, charts, graphs, drawings, vocabulary cards, demonstrations, specimens, models, objects, exhibits, field trips, museums, metronoscopes, telebinoculars, and projectors.

"The purposes in using visual aids are:

(1) to supply a need for supplementary teaching;
(2) to enrich and vitalize instruction;
(3) to economize learning and teaching time;
(4) to help develop proper concepts.

"The value of any teaching aid depends not on its intrinsic quality, but rather upon the use made of it at any particular time and in a particular situation. Successful achievement of objectives depends upon the presence of qualities in an aid such as accuracy, realism, comprehensibility, and interest.

"Once a teacher becomes interested in using visual aids, his enthusiasm for their value will lead him to be ever alert in discovering new sources of materials and in adding to his collection of these."

The report of the Nominating Committee was as follows:

For Chairman: H. A. Oetting, East Alton Wood-River High School, Wood River, Illinois.

For Vice Chairman: Miss Margaret Rio, Oblong Township High School, Oblong, Illinois.

For Secretary: Mark Anderson, High School, Watertown, Wisconsin.

The report was accepted.

The next speaker was Willard M. Gersbacher, Head of Department of Zoology, Southern Illinois Normal University, Carbondale, Illinois. He

presented a paper on the subject "Are General Science Courses Meeting the Needs of the High School Students?" Mr. Gersbacher stated that he was interested in General Science from two points of view: (1) because he is employed in a teacher training institution which is sending people into the scientific field; (2) freshmen entering frequently try to avoid sciences and mathematics due to some form of fear. In conclusion Mr. Gersbacher made the following statement: "I have endeavored to show that courses in High School Science should be practical, and that the student should acquire the scientific attitude in meeting personal and community problems. Perhaps the needs of the high school student in General Science are too great to be included in a single year of work. Still in many schools there is a tendency to eliminate science as a required course, and in other schools only one year of General Science is required. We are faced with the Problem." Are your General Science Courses meeting the needs of the students?"

The third speaker, Mr. Eggert Meyer, of the Francis W. Parker High School, Chicago, Illinois, spoke on "Scientific Attitudes in Children in Times of Crisis." He believes the general science course should provide for experiences in the field of science that are meaningful to the child. It should promote the right attitudes and prevent faulty ones; it should replace services for fears, and it should give the student a desire for "the will to do" by applying what he has learned in the science classes. The correct scientific attitudes are the strongest weapons that a democracy can provide toward total defense.

The last speaker, Mr. Alden Greene, Proviso Township High School, Maywood, Illinois, gave "Techniques in the Demonstration of Liquid Air." He demonstrated and explained the unique experiments just as he would before the science classes in the laboratory.

MARGARET RIO, *Secretary*

MATHEMATICS SECTION

Presiding; Professor H. G. Ayre.

Mr. Runge, of the Evanston, Illinois, High School, presented the report of the Nominating Committee. The following officers were elected for the following year: Chairman, Mr. George Hawkins, of Lyons Twp. High School, La Grange, Illinois; vice-chairman, Mr. Joe Kettery, of Arsenal Technical Schools, Indianapolis, Indiana; and secretary, Mr. E. G. Hexter, of the Belleville, Illinois, High School.

The first speaker, Mr. Henry W. Syer of Culver Military Academy, gave a very stimulating illustrated talk about, "Making and Using Moving Pictures for the Teaching of Mathematics." He discussed subjects desirable for moving pictures, the equipment necessary, the techniques to be developed, and what we may expect both as to the moving pictures and their classroom use. He gave very practical advice from actual experience, and showed by his pictures the marvelous results which he has already obtained. A report about his work is to appear in a Yearbook of the National Council, from which all can get his advice direct. There followed a short discussion period.

Dr. Ayre then introduced Mr. Anatol Rapoport, of the University of Chicago, who spoke on "Mathematics and Music." He said that although mathematicians are very often interested in music and are very often musical, mathematics does not help one with his music. He traced the connection between mathematics and music from the time of the early Greeks down through the Middle Ages and to the present, showing the mathematical imperfections of all existing systems of music, and that although a more perfect system has been demonstrated and proposed, it has not yet been tried. At the end of his talk, he favored the audience, at their request, with a selection from Bach.

Dr. Ayre thanked the speakers and the committee members who had helped in arranging and carrying out the program so successfully. He said that although it had been decided not to have a set theme for the program, such a theme might easily have been "Mathematics in Action."

After some announcements, the chairman of the Exhibit Committee, Mr. William A. Richards of the J. S. Morton High School and Junior College, Cicero, Ill., talked about the exhibit on display at the convention, and called for statements from members of his and other exhibit committees. Miss Chrisman, Senn High School, Chicago, spoke about the beginning of the cooperative exhibit movement in the Chicago area. Mr. Jenkins, Foreman High School, Chicago, president of the Chicago Men's Mathematics Club, told about a current exhibit at the Planetarium, which he urged all to see. Miss Mildred Taylor, Fenger High School, Chicago, president of the Women's Mathematics Club of Chicago, talked about the need for publicity in connection with successful exhibits, and gave practical suggestions for such publicity. Dr. Ballard, Wright Junior College, Chicago, told about the string designs as mathematical projects for all levels of students, and called attention to those from Washington, D. C., on display as part of this convention's exhibit. Mr. Richards made special mention of the schools participating in this exhibit. They included the Chicago Teachers' College, Englewood, Fenger, Senn, Steinmetz, Tilden Technical and Von Steuben High Schools of Chicago, Downers Grove, Ill., High School, Dundee, Ill. High School, Evanston, Ill. Twp. High School, Kankakee, Ill. High School, Washington, D. C. High Schools, Watseka, Ill. High School, and Waukegan, Ill. High School.

AGNES MACNEISH, *Acting Secretary*

PHYSICS SECTION

Presiding: George E. Peterson

Dr. Karl Lark-Horovitz, Head of the Department of Physics of Purdue University, discussed the "Problem of Physics in the High School." He emphasized that the high school should not primarily teach physics to prepare for college. How does a college professor come into contact with the high school situation? Chiefly through his contacts with incoming freshmen in his own classes. Purdue has a widely varied geographic sampling of students. Results of questionnaires to incoming students show that most feel that their high school physics courses were of definite value to them. However, fully sixty per cent of the incoming freshmen cannot handle simple arithmetic problems involving common fractions. It is possible for teachers in Illinois and Indiana to secure teaching certificates entitling them to teach high school physics when they have had no high school preparation in the subject and as little as three semester hours of college physics.

How many large corporations would employ people in their research departments merely upon the basis of having been high school physics teachers? Purdue maintains upon its physics staff at all times some individuals who have had high school teaching experience. To these men is delegated the task of preparing future teachers. University physics departments are responsible for preparing teachers for the secondary school sciences. But where do teachers of science in the smaller high schools come from? Because of State and Federal aid, most of the smaller communities have Smith-Hughes teachers in vocational subjects, and it is customary for science classes to be assigned to them as related science subjects. As a result science teaching is frequently relegated to a place of minor importance in the high school curriculum.

What can be done about the offerings of secondary school sciences? In Indiana it is being requested that all teachers be certified for specific sub-

jects and not allowed to teach outside their special fields. An increased time spread for the same amount of teaching material would help. If physics were taught for only half the time each week but continued for two years, it would help in student mastery. There is definite need for further correlation between the various sciences. It is of the utmost importance that the student gain real working concepts rather than just the mere shell of formalized learning.

Finally, in-service training is needed. On the meager salaries of secondary school teachers, it is impossible for any extensive, in-residence training to be developed. Purdue is offering in the summer of 1942 a short four weeks course for high school physics teachers. This is an effort to meet the in-service training needs of the smaller schools.

Dr. C. W. Jarvis of Ohio Wesleyan University spoke on "Making Physics Interesting to High School Students." His chief thesis was that it is the job of the high school teacher to first gain the interest of the pupil. The more mathematical phases of the subject should be reserved for the more advanced student and not used upon the beginner. A more detailed report of Dr. Jarvis' paper will appear later in the JOURNAL.

The nominating committee recommended the following for election as officers, and the recommendations were approved by unanimous consent. For chairman, E. O. Bower, East Technical High School, Cleveland, Ohio; vice-chairman, P. A. Tapley, Von Steuben High School, Chicago, Illinois; and for secretary, Dr. C. W. Jarvis, Ohio Wesleyan University, Delaware, Ohio.

Professor H. Landsberg, of the Institute of Meteorology, University of Chicago, presented an interesting and instructive paper on "Developments in Exploring Atmosphere and Lithosphere."

Mr. Herbert Hainesworth of the Central Scientific company, presented a number of the newer items offered by this firm.

Mr. H. E. Brown, of the Welch Scientific Company, demonstrated the Wood Gratings. After a brief presentation of the history of diffraction gratings, a number were distributed throughout the audience so that everyone could hold the grating to the eye and observe the spectra of both a bright filament and also of a monochromatic violet light source. Because of the simplicity of the experiment and also of the inexpensive price of the gratings made today, Mr. Brown stated that every high school could afford to include an experiment in measuring the wave length of light.

Two students of Mr. James Perdue, Tuley High School, Chicago, gave a very interesting presentation of what can be done to stimulate high school students to work out their own demonstrations. Miss Thelma Kass and Mr. Hugo Korn demonstrated ultra-violet light. Besides showing several specially prepared banners, they showed the fluorescence of common vaseline and of teeth. A Bell & Howell Filmo Sound projector was used for picking up a beam of light and reproducing sound which was sent across the room on the light beam.

PHILIP A. TAPLEY, *Secretary*

THE SATURDAY MORNING GENERAL SESSION

During this general session two papers were presented. The first was a report prepared by Dr. S. R. Powers, of Columbia University, on "Professional Education of High School Teachers Specializing in Science." Professor Powers was prevented by illness from reading his own paper, but it was very ably presented by an assistant, Dr. Anita Layton.

In his paper entitled, "Into Unseen Worlds, The Electron Microscope," Dr. James Hillier, of the RCA Research Laboratories, first reviewed the principles of optics upon which the conventional micoscope is based, and

then emphasized the similar usage of electromagnetic fields in directing electron streams to provide the enormous magnifications attainable with this marvelous device. The instrument itself and technics of its use were described. Slides were used to reveal the startling results of investigations already carried out with this new instrument.

THE FRIDAY EVENING BANQUET

The annual banquet provided the stage for presentation of Honorary Memberships by the Association to two of its most respected members, Professors E. R. Breslich and Glen W. Warner. These men, both past presidents of the Association, have given remarkable service to their profession for many years, not only as teachers, but also as writer and editor.

The lecture which followed was a remarkable combination of entertainment and scientific demonstration, by Dr. J. O. Perrine, already a favorite of those who heard him at our banquet in 1938. Utilizing perhaps a ton of electrical equipment which required two assistants eight hours to set up, Dr. Perrine and his helper, Miss Swenson, first demonstrated the formation of basic speech sounds by electrical means. They then proceeded to combine these into sounds of the complex sorts found in speech. The audience itself was quite electrified as these words were welded into complicated sentences, with the pitch controlled to provide tunes, with a climax coming with the singing of a duet by the voder with Mr. McGrath, an employee of the Western Electric Company in Chicago. Mr. David Levenger, general manager of the Hawthorne Works of the Western Electric Company, was a guest at the banquet.

THE SATURDAY MORNING SECTION GROUPS

As in previous conventions, part of the Saturday forenoon was devoted to programs developed for different grade levels. Part of these are being reported elsewhere, and several of the papers will be published in the journal.

In the Junior High School Group, a demonstration class under the direction of Marie W. Sperks, of the Farnsworth School in Chicago, made a study of the determination of taxes in the community. Miss Anna P. Keller, District Superintendent of the Chicago Public Schools, demonstrated methods of recording Nature's Forms, and was followed by a discussion of methods of Reading Nature's Records, by May Theilgaard Watts.

Speaking before the Senior High School Group, Professor Harold Fawcett, of Ohio State University, described a program of mathematics which he believed would contribute more fully to the goals of general education.

Professor Robert J. Havighurst, University of Chicago, spoke on "The Science Teacher of the Future." He stated that the science teacher must be a dual personality. In the classroom he must be a qualified science teacher, with an adequate background of science training and with broad acquaintance with the applications of science in the community. Secondly, this science teacher must be a person of the community who can defend science against the pessimism of community opinion. He must exude faith in the future of science for good, and must have an enthusiasm for science and for its ability to progress by overcoming difficulties.

In the Junior College Group Sister Mary Ellen O'Hanlon, of Rosary College, presented a profound discussion of the place of the scientist and the scientific method in our society. She pointed out that the scientist as such is not responsible for the uses made of his discoveries, but that he is also a man—an ethical and moral being—and as such may not be indifferent to the abuses of his accomplishments.

The Secretary wishes to acknowledge indebtedness to several teachers for assistance in compiling this report, especially to Mr. M. E. King and Mr. Jack Rossetter of Oak Park High School, Mr. Wayne Guthrie of Griggsville, Illinois, and Mr. Elmer Kunze of Decatur, Illinois.

REPORT OF THE NOMINATING COMMITTEE

For President: Dr. Joel S. Georges, Wright Junior College, Chicago.

For Vice-President: Miss Villa B. Smith, John Hay High School, Cleveland, Ohio.

For the Board of Directors:

Mr. Joseph E. Dickman, Board of Education, Chicago
Mr. M. D. Oestreicher, Francis W. Parker Schools, Chicago
Mr. Joseph W. Rhodes, Senior High School, Beloit, Wisconsin
Mr. Kenneth E. Vordenberg, Washington Junior High School, Cincinnati.

signed,

A. C. BROOKLEY
E. S. MARTIN
N. A. NEAL
G. K. PETERSON
J. M. KINNEY, *Chairman*

REPORT OF THE RESOLUTIONS COMMITTEE

I

WHEREAS, Many Science and Mathematics Teachers have already enlisted in the Defense Service of our country; and

WHEREAS, The Defense Program must necessarily be based largely upon Science and Mathematics;

Be It Hereby Resolved, That we offer our services both as individuals and as an organization, to perfect our Defense Program and to educate the youth concerning the needs for National Defense.

II

WHEREAS, The Central Association of Science and Mathematics Teachers has served the interests of youth and teachers for nearly half a century, and during that time has built many loyalties and upheld ideals of effective teaching;

Be It Hereby Resolved, That we approve the formation of a National organization, whose purpose shall be to coordinate and to integrate the science and mathematics teaching programs of the various organizations but not to replace or to dominate those organizations.

III

WHEREAS, There are in the Central States many local Science and Mathematics teachers clubs who work more or less independently and whose programs may be a stimulus to other clubs or who may get stimulus from other clubs;

Therefore Be It Resolved, That the Central Association appoint a committee to develop a technique whereby these clubs may become affiliated with The Central Association of Science and Mathematics Teachers but not to be replaced by nor dominated by The Central Association of Science and Mathematics Teachers.

IV

WHEREAS, Chicago is centrally located and easily accessible to the ter-

ritory served by The Central Association of Science and Mathematics Teachers;

Therefore, Be It Resolved, That we meet regularly in Chicago at least two out of every three years.

V

WHEREAS, The laws governing certification and licensing have been in effect, with but slight modification, for many years; and

WHEREAS, In the light of modern developments and with increasing demand for people trained in the fundamentals of the sciences and their applications, new licensing combinations should be considered;

Therefore, Be It Resolved, That this Association favors license combinations in one comprehensive area only—sciences and mathematics; and

Be It Further Resolved, That we oppose the customary grouping of unrelated licenses in several comprehensive areas such as science, social studies, and languages; and

Be It Further Resolved, That we also oppose the teaching of science by persons not adequately trained on the basis of a temporary permit; and

Be It Further Resolved, That teacher's training requirements for certification should be determined by the subject matter departments.

REPORT OF THE NECROLOGY COMMITTEE

William S. Buttles, of 10728 S. Artesian Ave., Chicago, Illinois, died during August 1940. Mr. Buttles was a designer and manufacturer of reflecting telescopes.

Professor J. A. Drushel, Professor of Mathematics at New York University, died in June, 1940. He had been a member of the Central Association of Science and Mathematics Teachers since 1921, and had been an active worker in the field of mathematics.

Professor Dayton C. Miller, Chairman, Physics Department, Case School of Applied Science, Cleveland, Ohio, died during the spring of 1941. He was an honorary member of the Central Association of Science and Mathematics Teachers. His specialty was sound, the analysis of sound with his "phonodyke" being one of his major accomplishments. He also did work on the ether drift. Additional information is provided in *Who's Who.*

Mr. O. C. Osborn, Head of Science Department, Central High School of South Bend, Indiana, died during December, 1940. He was a member of this Association for many years, and was chairman of the Physics Section in 1940. He had been connected with the South Bend schools for 28 years.

CLARENCE J. LEONARD, *Chairman*

EDITORIAL TECNICA UNIDA

In conjunction with our policy of improving relations with Latin America and to help our southern neighbors to replace French, German, Italian and Spanish technical and scientific books, the CHEMICAL PUBLISHING CO. INC., Brooklyn, N. Y. has formed a Latin-American Publishing Co., called EDITORIAL TECNICA UNIDA. The latter has already published 37 bulletins and 12 books, 20 additional books are in process.

The subjects of these bulletins and books, which are printed in Spanish and Portuguese, are Aeronautics, Engineering, Industrial Processes, Metals and Metal Working, Agriculture, Chemistry and Formularies. Also Commercial, Technical, and Military dictionaries.

Circulars describing these books are available.

The editor-in-chief of this division is Dr. Antonio Guerrero, a graduate of the University of Madrid. Dr. Guerrero holds degrees in chemical, electrical, and mechanical engineering. He was formerly engaged in industrial practice in various engineering capacities.

A CALENDAR OF THE BIRTHDAYS OF SCIENTISTS FOR JANUARY[1]

JAMES D. TELLER
College of Education, Ohio State University

Day	*Year*	*Name*	*Birthplace*	*Specialty*
1	1861	Pierre Marcel in Boule	Montsalvy, France	Scientist
1	1854	Sir James George Frazer	Glasgow, Scotland	Anthropologist
1	1846	Rodolfo Amadeo Lauciani	Rome, Italy	Archaeologist
1	1815	Samuel Cunliffe Lister Marsham	Near Bradford, England	Inventor
2	1889	Roger Adams	Boston, Massachusetts	Chemist
2	1821	James Croll	Near Cargill, Scotland	Scientist
3	1823	Robert Whitehead	Bolton-le-Moors, Lancashire, England	Inventor
4	1737	Louis Bernard Guyton de Morveau	Dijon, France	Chemist
6	1842	Clarence King	Newport, Rhode Island	Geologist
6	1822	Heinrich Schliemann	Neu Buckow, Mecklenburg-Schwerin, Germany	Archaeologist
7	1560	Gaspard Bauhin	Basle, Switzerland	Botanist
7	1745	*Johann Christian Fabricus	Jondern, Denmark	Entomologist
7	1794	Eilhardt Mitscherlich	Oldenburg, Germany	Chemist
7	1833	Sir Henry Enfield Roscoe	London, England	Chemist
8	1868	Sir Frank Watson Dysan	Leicestershire, England	Astronomer
8	1823	*Alfred Russel Wallace	Usk, Monmouthshire	Naturalist
9	1870	Amadeus William Grabou	Cedarburg, Wisconsin	Palaeontologist
10	1729	*Lazaro Spallanzani	Scandiano, Modena, Italy	Scientist
11	1850	Joseph Charles Arthur	Lowville, New York	Botanist
11	1889	Calvin Blackman Bridges	Schuyler's Falls, N. Y.	Genetician
11	1865	Johannes Franz Hartmann	Erfurt, Germany	Astronomer
11	1825	*William Spottiswoode	London, England	Physicist
12	1812	William Pengelly	East Looe, Cornwall, England	Geologist
13	1843	Sir David Ferrier	Aberdeen, Scotland	Neurologist
13	1845	François Félix Tisserand	Nuits-Saint-Georges, Côte d'Or, France	Astronomer
13	1864	*Wilhelm Wien	Gaffken, East Prussia	Physicist
14	1848	Rudolph Messel	Darmstadt, Germany	Chemist
15	1859	Nathaniel Lord Brittan	Staten Island, New York	Botanist
15	1870	Ulysses Prentiss Hedrick	Independence, Iowa	Horticulturist
16	1745	Antonio José Cavanilles	Valencia, Spain	Botanist
16	1805	William Jory Henwood	Perran Wharf, Cornwall, England	Geologist
17	1706	*Benjamin Franklin	Boston, Massachusetts	Natural Philosopher
17	1501	Leonhard Fuchs	Wembdingen, Bavaria	Botanist
17	1761	Sir James Hall	Dunglass, Scotland	Geologist
17	1837	François Lenormant	Paris, France	Archaeologist
17	1834	*August Weismann	Frankfurt-on-Main, Germany	Biologist
18	1815	Warren de la Rue	Guernsey, England	Astronomer
18	1825	*Sir Edward Frankland	Near Lancaster, England	Chemist
19	1813	*Sir Henry Bessemer	Hertfordshire, England	Inventor
19	1747	Johann Elert Bode	Hamburg, Germany	Astronomer
19	1851	David Starr Jordan	Gainesville, N. Y.	Naturalist
19	1763	*James Watt	Greenock, Scotland	Inventor

[1] All data are taken from *The Encyclopaedia Britannica*, 14th edition. For the uses and limitations of such a calendar, the reader is referred to the article which accompanies the calendar for October in SCHOOL SCIENCE AND MATHEMATICS, Vol. XLI, pp. 611–619, Oct. 1941. The calendar for November will be found in *Ibid.*, p. 768, Nov. 1941 and that for December in *Ibid.*, pp. 884–885, Dec. 1941.

* The starred names have been used by the writer in various bulletin board projects during the past twelve years.

Day	Year	Name	Birthplace	Speciality
20	1877	Harold Maxwell Lefroy	Crondall, Hants	Entomologist
21	1847	Joseph Achille Le Bel	Pechelbronn, France	Chemist
22	1775	*André Marie Ampère	Near Lyons, France	Physicist
22	1561	*Francis Bacon	London, England	Philosopher of Science
22	1592	Pierre Gassendi	Provence, France	Scientist
23	1785	Karl Adolf Agardh	Badstad, Sweden	Botanist
24	1828	Ferdinand Julius Cohn	Breslau, Germany	Botanist
25	1878	*Ernst F. W. Alexanderson	Uppsala, Sweden	Inventor
25	1627	*Robert Boyle	Lismore Castle, Ireland	Natural Philosopher
25	1796	William Macgillivray	Aberdeen, Scotland	Naturalist
26	1831	Heinrich Anton De Bary	Frankfurt-on-Main, Germany	Botanist
27	1876	William Crocker	Medina, Ohio	Botanist
27	1832	Reginald Stuart Poole	London, England	Archaeologist
30	1822	Franz Hauer	Vienna, Austria	Geologist
31	1881	*Irving Langmuir	Brooklyn, New York	Chemist
31	1814	*Sir Andrew Crambie Ramsay	Glasgow, Scotland	Geologist
31	1868	*Theodore William Richards	Germantown, Pa.	Chemist

"BRAIN WAVE" MACHINE GUIDES SURGEONS TO HIDDEN TUMORS, RADIOLOGISTS TOLD

Magic fingers of a "brain wave" machine point to hidden tumors in the human brain enabling surgeons to operate more efficiently, Dr. E. R. Witwer, of Detroit, reported to the Radiological Society of North America.

Physicians call the "brain wave" machine the electro-encephalograph. It records on charts tiny waves stimulated by the electric currents of the brain. Unlike healthy brain tissue, tumors seem to generate no current. The tissue around the tumor, however, displays a variety of waves which usually are below 4 cycles per second. These are called Delta waves. They interfere with the normal tracing in the area of a tumor, producing a Delta focus. Presence of such a focus can often guide the surgeon to the tumor, Dr. Witwer explained.

Dr. Witwer also described the brain surgeon's use of a "petrographic microscope" which uses polarized light without necessity for staining the tissue under study. Just beginning to be used by brain surgeons, this special microscope reveals sub-microscopic changes in brain tissue early in tumorous growth, Dr. Witwer said.

Dr. John W. Camp of the Mayo Clinic at Rochester, Minn., told physicians how calcified areas of the brain may be distinguished from the shadows produced in the roentgen photographs of brain tumors. Calcification of some portions of the brain, while not normal, may not be the result of disease, he said.

HEATH GIVES DEFENSE BONDS

Every employee of D. C. Heath and Company, educational publishers, with a staff covering the whole country, has been given a United States Defense bond as part of a bonus in recognition of faithful and effective service during the past year.

The presentation of the bonds is made not only to indicate the desire of the Company to support the efforts of the Government to meet urgent needs, but also as a hint to the recipients that the gift might be used as a foundation on which to build their own offerings.

D. C. Heath and Company has its home office in Boston, with other fully staffed offices in New York, Chicago, Atlanta, Dallas, and San Francisco and a staff of representatives assigned to every stage, Puerto Rico, Hawaii, and the Philippines.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1712. *Walter R. Warne, Rochester, N. Y.*
1724. *Bessie Lucas, Earlville, N. Y.*

1729. *Proposed by P. D. Thomas, Norman. Okla.*

If in a triangle ABC, a^2, b^2, c^2 are in arithmetic progression, then tan A tan B, tan C are in harmonic progression.

Solution by Norman Anning, University of Michigan

Let d = diameter of circumcircle. From trigonometry $d \sin A = a$, $d \sin B = b$, $d \sin C = c$. Also from Law of Cosines, $\cos A = (b^2+c^2-a^2)/2bc$, etc. Then using well known definitions and theorems we have the following arithmetic progressions:

a^2, b^2, c^2; $-2a^2, -2b^2, -2c^2$; adding $a^2+b^2+c^2$ gives $b^2+c^2-a^2$, $a^2+c^2-b^2$, $a^2+b^2-c^2$;

$$\frac{b^2+c^2-a^2}{2abc}, \quad \text{etc.};$$

using $d \sin A = a$ etc., and Law of Cosines,

$$\frac{\cos A}{d \sin A}, \quad \frac{\cos B}{d \sin B}, \quad \frac{\cos C}{d \sin C};$$

$\cot A$, $\cot B$, $\cot C$

$\therefore$ tan A, tan B, tan C are in harmonic progression.

Solutions were also offered by A. K. Suter, Indianapolis, Ind.; P. D. Thomas, Norman, Okla.; Walter R. Warne, Rochester, N. Y.; John P. Hoyt, Annapolis, Md.; Malcolm Kirk, West Chester, Pa.; Roy Wild, New Boston, Mo.

1730. *Proposed by W. S. Wilson, Ovid, N. Y.*

Show that $(ab+cd)\ (ac+bd)>4\ abcd$, if a, b, c, d are unequal positive numbers.

Solution by A. K. Suter, Indianapolis, Ind.

Let a, b, c, d be unequal positive whole numbers.

Then $(a-d)^2>0$, and $(b-c)^2>0$. Also

$bc(a-d)^2>0$, and $ad(b-c)^2>0$.

Adding

$$bc(a-d)^2+ad(b-c)^2>0,$$
$$vca^2-2abcd+bcd^2+adb^2-2abcd+adc^2>0,$$
$$a^2bc+bcd^2+ab^2d+ac^2d>4abcd,$$
$$\text{or } (ab+cd)\ (ac+bd)>4abcd.$$

Solutions were also offered by S. E. Field, Ironwood, Mich.; A. D. Suttle, Jr. Mississippi; Malcolm Kirk, West Chester, Pa.; Gordon Duvall, Cincinnati, Ohio; Walter R. Warne, Rochester, N. Y.; Georgia V. Rolison, Benton Harbor, Mich.; Roy Wild, New Boston, Mo.

1731. *Proposed by C. W. Trigg, Los Angeles City College.*

If A and B are positive numbers greater than unity and $AB=C$, then $\log_{c^2}A+\log_{c^2}B+\log_{A^2}C+\log_{B^2}C\geqq 17/2$.

Solution by the Proposer

$AB=C$, so $\log_c A+\log_c B=1$.

$\log_A C=1/\log_c A$.

It was shown in No. 1686, page 199, Feb. 1941 that if a and b are positive and $a+b=1$, then $(a+1/a)^2+(e+1/b)^2\geqq 25/2$. When this is expanded we have $a^2+2+1/a^2+b^2+2+1/b^2\geqq 25/2$, so $a^2+1/a^2+b^2+1/b^2\geqq 17/2$.

Upon substituting $\log_c A$ for a $\log_c B$ for b, we have the required inequality.

Editor's Note: Anna K. Suter, Indianapolis, Ind. and Malcolm Kirk, West Chester, Pa. worked the problem with the exponent, 2, affecting the base of the Logarithm in each case and found the lower limit to be 5/2.

1732. *Proposed by Vernon Van Derenter, Los Angeles, Calif.*

Prove

$$(1-\sqrt{3})\sqrt{2+\sqrt{3}}=-\sqrt{2}.$$

Solution by A. K. Suter, Indianapolis, Ind.

(1) $$\sqrt{2+\sqrt{3}}=\sqrt{\frac{3+2\sqrt{3}+1}{2}}=\frac{1+\sqrt{3}}{\sqrt{2}}$$

Multiply by $1-\sqrt{3}$

(2) $$(1-\sqrt{3})\sqrt{(2+\sqrt{3})}=\frac{1-\sqrt{3}}{\sqrt{2}}=-2/\sqrt{2}=-\sqrt{2}$$

$$\therefore\quad (1-\sqrt{3})\sqrt{(2+\sqrt{3})}=-\sqrt{2}.$$

Editor's Note: Several solutions started with the proposition to be proved, treated it as an equation, squared both members, and arrived at the truth $2=2$. From this it was assumed that the original was true. This is false reasoning. By the same reasoning one can prove $3=1$.

Thus let $3=1$. By subtraction

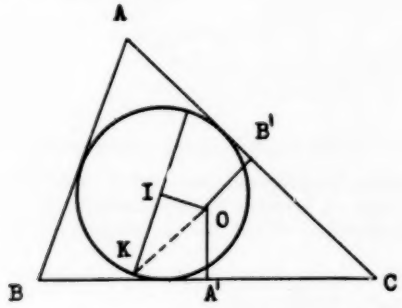
$1=-1$ By squaring

$$1=1.$$
$$\therefore \quad 3=1.$$

It is so often overlooked that it is necessary to show that the steps taken in reverse order can be made.

Solutions were also offered by A. D. Suttle, Miss.; John S. Miller, New Orleans, La.; Walter R. Warne, Rochester, N. Y.; Floyd Wheelan, West Henrietta, N Y.; Gaye McKaac, Wilmington, Calif.; Ethel Henry, Wilmington, Calif.; Bob Campbell, Ironton, Ohio; William Pauly, Cincinnati, Ohio; Constance Jones, San Antonio, Texas; Kenneth P. Carlson, Hershey, Neb.; Malcolm Kirk, West Chester, Pa.; S. E. Field, Ironwood, Mich.; and the proposer.

1733. *Proposed by William W. Taylor, Woodrow Wilson Junior High School, Port Arthur, Texas.*



The line through the incenter of a triangle and perpendicular to the line adjoining the incenter with the circumcenter meets the incircle in two points. Show that the distance from the circumcenter to either of these two points is equal to the difference of the circumradius and inradius.

Solution by the Proposer

Let K be one of the points on the circumference of the incircle, O the circumcenter, I the incenter, R the circumradius, and r the inradius.

The distance OI is given by the relation

$$\overline{OI}^2=R^2-2Rr. \tag{1}$$

Adding r^2 and subtracting r^2 it is seen that

$$\overline{OI}^2=R^2-2Rr+r^2-r^2 \tag{2}$$

$$\overline{OI}^2=(R-r)^2-r^2. \tag{3}$$

But (3) is now the same as the Pythagorean Theorem applied to right triangle OIK.

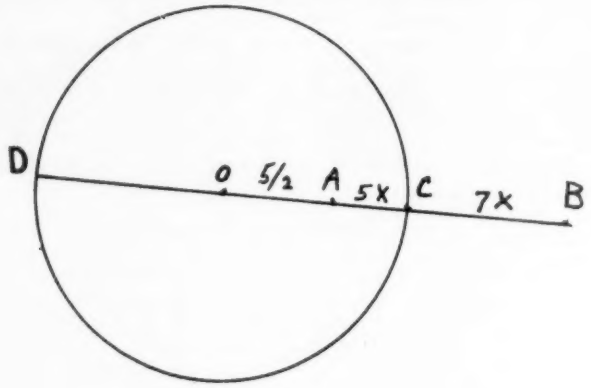
$$\therefore \quad OK=R-r.$$

Solutions were also offered by M. Gordon Duvall, Cincinnati, Ohio; John P. Hoyt, Annapolis, Md.; D. F. Wallace, St. Paul, Minn.; A. MacNeish, Chicago, Ill.; Malcolm Kirk, West Chester, Pa.

1734. *Proposed by Thomas A. Pickett, S. Weymouth, Mass.*

The walls of an ancient city were so constructed that the distances from any point on the wall to two isolated hills fromed a constant ratio 7:5. If one hill inside the walls is $2\frac{1}{2}$ miles from the center of the city, what

is the shortest distance from the other hill to the wall? And what is the distance around the city by way of the walls?



Solution by John P. Hoyt, Annapolis, Md.

By an elementary locus problem, the Circle of Appolonius, the wall of the city is in the form of a circle whose diameter is the line joining the points of harmonic division of the line joining the 2 hills in the ratio of 5:7.

Let A and B represent the hills. Let C and D be points dividing BA internally and externally in the ratio 7/5.

Let $AC = 5x$ and $CB = 7x$. Then the radius $OC = 5x + 5/2$ and $AD = 5x + 5$

By conditions given, $BD/DA = 7/5$. Subtracting 1

$$\frac{AB}{DA} = \frac{2}{5} \quad \text{or} \quad \frac{12x}{5x+5} = \frac{2}{5}$$

from which $x = 1/5$ and $7x = CB = 7/5 = 1.4$ mi. and $OC = 7/5$ or $C = 7\pi$

Solutions were also offered by Walter R. Warne, Rochester, N. Y.; D. F. Wallace, Mich. and the proposer.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

No high school student contributions have been received. What is wrong? We want your solutions. Editor.

1720. Jimmie Mizuno, Hershey, Neb.
1732. Gaye McKaac, Wilmington, Calif.
1932. Ethel Henry, Wilmington, Calif.
1732. Bob Campbell, Iron, Ohio.
1732. William Panly, Cincinnati, Ohio.
1732. Kenneth P. Carlson, Hershey, Neb.

PROBLEMS FOR SOLUTION

1747. *Proposed by Daniel Kinney, Hoyt's Corners, N. Y.*

Find the sum of the fourth powers of the roots of

$$x^3-2x^2+x-1=0.$$

1748. *Proposed by Blanche McGuire, Junius, N. Y.*

If a, b, c are the roots of $x^3+2x^2-3x-1=0$, find the value of $a^{-3}+b^{-3}+c^{-3}$.

1749. *Proposed by Walter R. Warne, Rochester, N. Y.*

An equilateral triangle with area 10,000 is surrounded by a walk of uniform width and equal to the area of the inscribed circle. What is the width of the walk?

1750. *Proposed by Howard Hoogland, Toronto, Canada*

In a right triangle if the hypotenuse and the sum of the other two sides are given, give a Euclidian construction to determine the three sides.

1751. *Proposed by Roy H. Luce, Chinchilla, Pa.*

The hypotenuse BC of a right triangle ABC is 35. A square $ADEF$, with each side 10, is placed so that E is on BC and AD and AF lie on AB and AC respectively. Find the length of AB.

1752. *Proposed by Dannis Wallenback, Montour Falls, N. Y.*

The sum of two roots of the equation $x^4-8x^3+21x^2-20x+5=0$ is 4. Explain why on attempting to solve this equation by use of this fact, that the method fails. (From Hall and Knight's Higher Algebra.)

SCIENCE QUESTIONS

January, 1942

Conducted by Franklin T. Jones,
10109 Wilbur Avenue, S.E., Cleveland, Ohio

Readers of SCHOOL SCIENCE AND MATHEMATICS *are asked to contribute:*
Questions, Problems, Answers, Comments, Suggestions.
Whatever is new or interesting in the teaching of Science.
On the desks of business men we find little framed mottoes with big letters such as—
THINK! and DO IT NOW!
The Editor of this Department asks you to think as you read and send in some of your Questions and Answers, and Do It Now.
(Put it on a postal card and mail at once. Don't feel that you have to be formal and write a letter.)
In every issue of SCHOOL SCIENCE AND MATHEMATICS *for 1941 there was a contribution in this Department from teachers and pupils in Elementary Science. You contribute the material, and such Questions and Answers, as you can and do use every day, will be published every month. Please respond early.*
(The Editor is supposed to have his copy in the printer's hands a month ahead of publication.)
Please do the Editor a favor—
If, and when, your read this issue, drop a postal card to Franklin T. Jones, 10109 Wilbur Avenue, S.E. Cleveland, Ohio. Say what you choose: but DO IT NOW!

This world is changing faster than the Map of Europe. The scientific world is changing too and making the world better, even while it wars.

In 1942 we shall try to keep up with SCIENCE and INDUSTRY. Please help with good and usable material for publication. Thanks.

A YEAR OLD AND NOT ANSWERED YET!

910. *Suggested by a Series of Non-Technical Articles in "NEWS and VIEWS of GENERAL MOTORS."*
What Makes an Automobile Go?

Answer—

1. An *internal combustion engine.*
   A *piston* travels back and forth in a *cylinder* with one end closed. An exploded mixture of gases in the closed end of the cylinder drives the piston away from the closed end. The *momentum* of the moving parts brings it back. A *connecting rod* changes linear into rotary motion and operates a *crank* which turns a *crankshaft*. The crankshaft turns a *drive-shaft* which turns, through sets of *gears*, the *drive wheels* and away goes the automobile.
2. The engine in an automobile is usually "four cycle."
   Cycle 1—The explosion cycle.
   Cycle 2—The back stroke to clear the cylinder of burnt gases.
   Cycle 3—The suction stroke to bring in a fresh charge of gases.
   Cycle 4—The compression stroke to compress the gas ready for another explosion.
3. *Gasoline*, and like fuels that can form explosive mixtures, makes the automobile go. So the *carburetor* makes the auto go and also the *fuel pump*.
4. The *spark* that ignites the mixture makes the auto go, and the *ignition system* that operates the spark.
5. The *intake valves* that introduce the mixture and the *exhaust valves* that handle the hot exhaust gases.
6. All the moving parts have to be *oiled* to keep the *bearings* from overheating and burning out. The *oil-pump* is highly important.
7. The cylinder block has to be cooled; if by water, the *radiator* makes the auto go.
8. Power must be transmitted from crankshaft to driveshaft through a *transmission*, or shift-bear box. A *clutch* disengages drive-shaft from gears in gearshift so it makes the auto go.
9. The *universal joints* in drive-shaft change axis of rotation so that wheels can stick to the road and the engine and power plant travel in the plane of the frame.
10. The *differential* "walks" the wheel on the inside of a curve so that the tire wear on the rear wheels is equalized. It permits the two parts of the rear axle to rotate at different speeds. The *ring gear* on the rear axle assembly drives the rear wheels and is driven by the propeller-shaft (drive-shaft).

So you see there are a lot of things that "make an automobile go."

It is a simple matter to get your name on the mailing lists of a number of industrial concerns who are helping "to keep us up with industry."

Henry G. Weaver (GQRA, No. 343) Director of Customer Research Staff, General Motors Corporation, Detroit, Mich., says:

"If you care to do so, you might send us the names of any of your friends or associates in educational work who might like to be on our *courtesy mailing list.*"

(I'll be glad to forward your name, if you tell me to. Use a post card if you wish. F. T. Jones.)

1941 AWARD FOR CHEMICAL ENGINEERING ACHIEVEMENT

The magazine "Chemical and Metallurgical Engineering" presents its 1941 award for chemical engineering to the Dow Chemical Co. of Midland, Mich., for the company's development of a process for recovering magnesium metal from sea-water in a huge plant recently completed at Freeport, Texas. (*Assoc. Press, New York, Dec. 2*).

(One cubic mile of sea-water will yield 570,000,000 tons of magnesium metal. It is reported that it will take 30 years to process this volume of sea-water.)

WHAT ABOUT FIRE BOMBS?

939. *Suggested by an article by William M. Pierce, a Supervising Chemical Engineer, as published in "Best's Insurance News" for October, 1941.*

"In peace time it is rather unusual that a destructive fire is started with deliberate intent. In 1939, there were approximately 655,000 fires in the United States and only 7,000 of these were of suspicious incendiary origin. —The losses from these fires amounted to $270,000,000.—Imagine, if you can, the amount of loss which would result from a series of air raids where the main weapon was INCENDIARY BOMBS.

"Each bomber can carry 2,000 small magnesium incendiary bombs, and it has been estimated that 75 out of the 2,000 will start serious fires. If each raid consists of 100 bombers, there will be 7,500 serious fires started as the result of each raid. The fires would be concentrated along a line of about 3 miles with a fire every 60 yards."

(*Abhorrent as the thought may be, we must, here in the United States, begin to prepare ourselves to meet the difficulties of putting out such fires since it would be beyond the ability of our public Fire Departments to cope with such a situation.*)

Some Questions about Incendiary Bombs

(*Answers follow at the close of the list of questions*)

1. What is an Electron Bomb? How is it ignited? How long will it burn? Now hot is the fire?
2. What is the reaction of this burning bomb with water? How can it be smothered? How put out by water?
3. What is a Thermite Bomb? How put it out?
4. What is a Phosphorus Bomb?
5. What is an Oil Bomb?
6. How organize to fight such fires?
7. What equipment should be provided?

Answers

1. An Electron Bomb weighs about 2 lb. and consists of a thick-walled magnesium cylinder filled with thermite. "The thermite is ignited by a percussion cap in the nose of the bomb which in turn ignites the magnesium, which is the actual incendiary agent. Once this bomb has been ignited it will burn 10 to 15 minutes at temperatures of about 2,000 degrees Fahrenheit."

2. This bomb reacts violently with water causing more intense fire. It can be smothered by sand. Also a water spray will wet down the surrounding material and prevent spread of the fire, then the water will overcome the bomb itself. A sprinkler system is effective against this type of bomb.
3. In a Thermite Bomb the major portion of the charge is the thermite itself which is a mixture of iron oxide and aluminum powder. It burns more rapidly and at a higher heat than the magnesium bomb. Put out the fire it sets.
4. The phosphorus bomb usually weights about 10 lb. It contains phosphorus, carbon disulphide and coal tar oil. The phosphorus is spontaneously inflammable at ordinary temperatures in air. It can be put out by water but will start again as soon as the surroundings dry out. It makes a slow, non-explosive fire.
5. Oil Bombs weight 50 to 60 lb. and contain inflammable oil, phosphorus, carbon disulphide and T.N.T. It spreads liquid fire which would have to be put out by a heavy stream of water or foam.
6. Groups must be trained to handle fires set by incendiary bombs. Fire drill is essential. Preparations must be made in advance.
7. The equipment which should be available is—

   A supply of water independent of mains; sand and dry earth; four three gallon buckets for each 8,000 sq. ft. of space; a hand force pump with 30 feet of half-inch hose and a dual jet nozzle; an extension ladder; a long-handled shovel; a long-handled scoop and hoe for removing bombs; a hand axe; a pair of heavy gloves; a large flash light or oil lantern; a fire-fighting mask; a soda-acid chemical fire extinguisher.

The information in this article is useful in dealing with the ordinary industrial or domestic fire. It can be obtained free from Employers' Liability Insurance Co.

SCHOOLS AND CLASSES SHOULD TAKE ADVANTAGE OF PRESENT INTEREST IN CONTROL OF FIRES FROM INCENDIARY BOMBS TO TEACH HOW TO FIGHT ORDINARY FIRES IN THE HOME AND FIELD.

THIS IS A MOST IMPORTANT PHASE OF CONSERVATION ORDINARILY LOST SIGHT OF. (Ordinary fire losses in 1939, $270,000,000, excluding forest and brush fires.)

Did you ever think of the devastating and extensive destruction of cover for birds and game, and the loss of life in wild life itself when a brush fire or forest fire occurs?

SCIENTISTS AND DEFENSE

941. What are scientists doing to aid defense?
(Question and Answers from SCIENCE NEWS LETTER for Sept. 6, 1941, pp. 154–155)

1. "The addition to flour and bread of vitamins and minerals which will heighten morale and benefit health."
2. "Psychological aspects of defense are more important in these times than ever before."
3. "The chemical cure of diseases (pneumonias and other infections) through the *sulfa* drugs."
4. "Frequency modulation (FM) radio promises a revolution in broadcasting."

5. "Shock treatment of schizophrenia."
6. "Continued development of aviation . . . as constructive for peace as destructive in war."
7. "The development of synthetic plastics—made from air, water, coal, oil, gas, salt, lime—to compete with metals, silk, glass, and perform many new tasks in our plastic world."
8. "New understanding of the extent and composition of the universe and the nature of their action."
9. "The use of new methods in genetics to produce bigger and better kinds of animals and plants for our farms."
10. Read "OPPORTUNITY FOR TEACHERS," page 155.

THE "SULFA-DRUGS" AGAIN

942. What are the "Sulfa-Drugs"?

Suggested by Paul de Kruif's article—"These Millions Need Not Die"—in THE READER'S DIGEST for December, 1941. Read the article.

The "Sulfa-Drugs" are:

Prontosil (early 1930's), effective against blood poisoning; *Sulfanilamide* (1936); *Sulfapyridine* (1938); within three years these three drugs cut the pneumonia death rate in half in the United States.

Sulfathiazole (1940); *Sulfadiazine* (April, 1940); The "sulfa-drugs" are the "coccus killers."

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943. The Eight Greatest Mysteries of Science

Bruce Bliven interviews leading research scientists and the result is printed in THE NEW REPUBLIC, November 17, 1941, condensed in THE READER'S DIGEST, December, 1941. Read the article.

(The *eight mysteries* are not listed here because the EDITOR does not wish to run the risk of involving SCHOOL SCIENCE AND MATHEMATICS in a suit for infringement of copyright. You ought to read the article for yourself anyway.)

WAR MATERIALS FROM FOREIGN COUNTRIES

From article by Vice-President Henry A. Wallace in COLLIERS, November 22, 1941.

944. Name the principal "essentials of war without which we can not defend ourselves; and without them, Germany cannot win."

Where do they come from?

(We in America think of our continent as "having everything"—all natural resources. The list below should bring us to a deeper realization of our dependency on our neighbors and friends.)

The following list is only partial:

NICKEL—used in armor plate. Our supply is mainly imported from Canada. We also get *all of the surplus* produced by Brazil.

TIN—All used in U.S.A. is imported from Malaya, Netherlands East Indies, Bolivia (*We get all surplus*), and Mexico.

TUNGSTEN—50% of U.S. consumption is imported from Bolivia, Mexico, Argentina, and China. Used in high speed tools and armor-piercing bullets.

LEAD—40% of domestic consumption is normally imported from Mexico, Chile, Peru, and Canada (alone sells us 225,000 tons per year).

MERCURY—Used in fulminates, and in paint for ship bottoms to prevent fouling by barnacles. American production is normally ⅓ of domestic needs. We import from Mexico; Germany from Italy and Spain.

MANGANESE—Essential in steel making. U.S. normally imports 90%. Sources Russia, India, Africa, Brazil, Cuba.

CHROMITE—Imported from Turkey, Africa, Cuba, Russia, Brazil, and "all the surplus" from the Philippine Islands.

BAUXITE—Source of aluminum of which 2,700 lb. to 27,000 lb. is used in each plane. Mostly imported from South America.

PLATINUM—Obtained mostly from Colombia, Canada, South Africa and the Soviet Union. Used in air-plane magnetos and as a catalytic agent in making smokeless powder.

INDUSTRIAL DIAMONDS—Used in tool-dressing and grinding. Source—Brazil.

MICA—Sheet mica comes from India, Brazil, Argentina. Used in condensers, generators, spark-plugs, and tubes as insulator. For a single battleship 100 lb. of sheet mica is a necessity.

QUARTZ CRYSTALS—Sending radios from planes must have piezo-electric quartz crystals. Source is Brazil.

CASTOR OIL—Used in making high-speed, high-temperature lubricants. Obtained by Japan from Brazil. We must now take Brazil's surplus.

PEANUT OIL—Flown to Germany from French West Africa. A German sub can operate for a year on 1,250 tons of peanut oil. Used as fuel on Diesel-powered engines.

MAGNESIUM—We can supply our own both for air-plane engine construction and for incendiary bombs; thanks to the Dow development in Texas (source sea-water), and to the U.S. subsidized plants for making "bomb magnesium."

VANADIUM, ZINC and COPPER—American mined; but we have to purchase surplus production of copper in Chile and Peru, and of other materials in South America to keep them from falling into Japanese hands.

ANSWER TO LINGREN'S "BEFORE CHRISTMAS" TEST

940. *Proposed by Vernon C. Lingren (GQRA, No. 410), Proviso Twp. H.S., Maywood, Ill.*

(See the Test Questions and Directions in SCHOOL SCIENCE AND MATHEMATICS, December, 1941.)

The answer, very appropriately is "MERRY CHRISTMAS."

Save it and use on your classes in December 1942.

JOIN THE GQRA!

I had no shoes and complained—until I met a man who had no feet.—*Arabian Proverb.*

"They conquer who believe they can. He has not learned the lesson of life, who does not each day surmount a fear."

Free advice is the kind that costs you nothing unless you act upon it.—*Atlanta Journal.*

BOOKS AND PAMPHLETS RECEIVED

COMMUNITY HYGIENE, by Dean Franklin Smiley, *Professor of Hygiene and University Health Officer in Cornell University*, and Adrian Gordon Gould, *Assistant Professor of Hygiene and Attending Physician in Cornell University*. Third Edition. Cloth. Pages xi+448. 14×21.5 cm. 1941. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.50.

WHAT IS MATHEMATICS, by Richard Courant, *Head of the Department of Mathematics, New York University*, and Herbert Robbins, *Instructor of Mathematics, New York University*. Cloth. Pages xix+521. 15×23 cm. 1941. Oxford University Press, New York, N. Y.

EYE HAZARDS IN INDUSTRY, by Louis Resnick. Cloth. Pages xx+321. 15×23 cm. 1941. Published for the National Society for the Prevention of Blindness by Columbia University Press, New York, N. Y. Price $3.50.

THE SUBJECT FIELDS IN GENERAL EDUCATION, Written in Collaboration by John J. DeBoer, *Director of Student Teaching, Chicago Teachers College*. Cloth. Pages ix+239. 14×21.5 cm. 1941. D. Appleton-Century Company, Inc., New York, N. Y. Price $1.50.

IDENTIFICATION OF ABILITY TO APPLY PRINCIPLES OF PHYSICS, by William Arlow Kilgore, *Teachers College, Columbia University Contributions to Education, No. 840*. Cloth. 34 pages. 15×23 cm. 1941. Bureau of Publications, Teqchers College, Columbia University, New York, N. Y. Price $1.60.

EARLY MILITARY BOOKS IN THE UNIVERSITY OF MICHIGAN LIBRARIES, by Thomas M. Spaulding and Lous C. Karpinski. Cloth. Pages xvi+45 +37. 19×28 cm. 1941. University of Michigan Press, Ann Arbor, Michigan. Price $2.00.

A BIBLIOGRAPHY OF MATHEMATICAL EDUCATION, by William L. Schaaf, *Assistant Professor of Education, Brooklyn College*. Paper. Pages viii+144. 15×23 cm. 1941. Stevinus Press, P. 0. Box 33, Forest Hills, N. Y.

PRACTICAL MATHEMATICS FOR SHIPFITTERS, by Louis Quentin Moss, *Special Assistant to the Principal, Jules E. Mastbaum Vocational School, Philadelphia, Pa.* Cloth. Pages xviii+108. 13×20.5 cm. 1941. Pitman Publishing Corporation, 2 West 45th Street, New York, N. Y. Price $1.50.

THE DEVELOPMENT OF MINERAL INDUSTRY EDUCATION IN THE UNITED STATES, by Thomas Thornton Read, *Vinton Professor of Mining Engineering, Columbia University, New York, N. Y.* Cloth. Pages xvii+298. 15×23 cm. 1941. American Institute of Mining and Metallurgical Engineers, 29 West 29th Street, New York, N. Y. Price $2.00.

RADIO TROUBLESHOOTER'S HANDBOOK, by Alfred A. Ghirardi, Author, "The Radio Physics Course," "Modern Radio Servicing," and "Radio Field Service Data." Revised and Enlarged Second Edition. Cloth. Pages x+710. 20.5×25 cm. 1941. Radio & Technical Publishing Company, 45 Astor Place, New York, N. Y. Price $3.50.

THE MARCH OF MEDICINE. New York Academy of Medicine Lectures to the Laity, 1941. Cloth. Pages xiv+154. 13×20.5 cm. 1941. Columbia University Press, Morningside Heights, New York, N. Y. Price $2.00.

MAN AND THE VERTEBRATES, by Alfred Sherwood Romer, *Professor of*

Zoology and Curator of Vertebrate Paleontology in the Museum of Comparative Zoology in Harvard University. Cloth. Pages viii+405. 16.5×22.5 cm. 1941. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill. Price $3.50.

MEASURING THE INTELLECTUAL AND CULTURAL BACKGROUNDS OF TEACHING CANDIDATES, by David G. Ryans. Paper. 28 pages. 17.5×25.5 cm. 1941. Cooperative Test Service, 15 Amsterdam Avenue, New York, N. Y.

WEEKDAY CLASSES IN RELIGIOUS EDUCATION, by Mary Dabney Davis, *Senior Specialist, Nursery-Kindergarten-Primary Education*. Bulletin 1941, No. 3. Pages vi+66. 14.5×23 cm. For sale by the Superintendent of Documents, Washington, D. C. Price 10 cents.

RCA LABORATORIES. Princeton, N. J. Paper. 36 pages. 15×23 cm. November 15, 1941.

BOOK REVIEWS

GENETICS AND THE ORIGIN OF SPECIES, by Theodosius Dobzhansky, *Professor of Zoology in Columbia University, New York*. Cloth. 15.5×23 cm. Pages xviii+446. 24 figures consisting of diagrams, maps and drawings, 24 data tables.

Professor Dobzhansky brings together in this book the efforts of genetics to throw light on the mystery of the origin and perpetuation of species. Our understanding of this mystery is slowly improving, this improvement resulting from the development of methods of research in genetics, especially the studies made during the last two decades. This book is a fine history of the methods of genetic research. The material of the book is divided under the following titles. 1—Organic Diversity. 2—Gene Mutation. 3—Mutation As a Basis for Racial and Specific Differences. 4—Chromosomal Changes. 5—Variation in Natural Populations. 6—Selection 7—Polyploidy. 8—Isolating Mechanisms. 9—Hybrid Sterility. 10–Patterns of Evolution. 11—Species As Natural Units.

The literature cited by professor Dobzhansky contains 869 titles. This indicates the thoroughness with which the field was studied.

Published by the Columbia University Press, Morningside Heights, New York 1941. $4.25.

A. G. ZANDER

BIOLOGY AND HUMAN AFFAIRS, by John W. Ritchie. Cloth. 16×23 cm. pages xiv+1026. Illustrations 726, diagrams 5. World Book Co., Yonkers on Hudson, New York. 1941. $2.32.

This large text is organized on the basis of 22 units composed of 124 problems. The unit titles are: 1—Why we Study. 2—The Diversity of Life. 3—The Unity of Life. 4—Changes in Living Things. 5—Fundamental Life Problems. 6—Methods and Problems of Reproduction. 7—A Study of Simple Organisms. 8—Two Representative Animal Groups. 9—The Cold blooded Vertebrates. 10—The Warm-blooded Vertebrates. 11—The Mammalian Body. 12—The Plant Plan. 13—Parasitology and Parasites. 14—Nutrition. 15—Heredity. 16—Behavior. 17—Animal Communities. 18—Types of Water Animals. 19—Life in the Sea. 20—The Land Plants. 21—Springtime Biology. 22—Our Biology Course.

This is a very comprehensive biology text for the secondary grade level.

It embodies a blending of the three types of method in approaching a study of the problems in biology teaching, the type, systematic and principles aspect of method. The material presented in this text could not be covered by an average class in one year. This is an advantage. There is enough material to take care of the speediest scholar in most any class of biology students. The design of the arrangement is such that library services can be reduced to a minimum and where such services are difficult to obtain the book fills a very great need.

The teacher using this text has considerable leeway in fitting his work to regional and seasonal differences. While the text costs a trifle more than the usual biology text this reviewer feels that the purchaser is getting his money's worth. At the end of most of the units short list of references is given. An appendix contains an illustrated classification of the plant and animal kingdom and a geological time-table. A glossary of 12 pages and a 26 page index.

A. G. ZANDER

LIFE SCIENCE, by Ralph C. Benedict, *Professor of Biology in Brooklyn College;* Warren W. Knox, *Director, Division of Secondary Education in the New York State Department of Education;* George K. Stone, *Supervisor of Secondary Education in the New York State Department of Education.* Cloth. 14.5×22 cm. Pages xix+682. Illustrations, tables and diagrams, 377. Macmillan Co., New York, 1941. $2.00.

The authors of this book bring to their readers an experience in curricular work, education and industry which has resulted in this latest of biology texts for the secondary school level students. The organization of the book is on the now familiar unit basis of which there are nine divided into 31 problems or parts. The Unit Titles are: 1—Life on Earth, 2—Similarities in Living Things. 3—Changes in Living Things. 4—Problems of Living Things. 5—Nutrition. 6—Response. 7—Reproduction. 8—Heredity. 9—Human Progress. The item in this book which held the reviewer's attention was the careful, correct drawings and diagrams, carefully and understandingly labelled. If the teacher uses these drawings in his assignments his students surely will be thinking with him. In Unit 6 on Response problem 21 is this illustrated. Here a structural diagram of the human eye appears. The relationship between the suspensory ligament and the complementary ciliary muscles is so nicely shown that one interested in this cannot but stop and study the diagram. This relationship is not shown as often as it should be in our biology texts. An appendix contains a simplified classification of the plant and animal kingdoms; a list of laboratory exercise titles with page references in the text. The lab work can be built right from the text with a minimum effort on the part of the busy teacher; a glossary of 325 terms and an adequate index.

A. G. ZANDER

BUTTERFLIES. A Handbook of the Butterflies of the United States, Complete for the Region North of the Potomac and Ohio Rivers and East of the Dakotas, by Ralph W. Macy, *Professor of Biology, College of St. Thomas* and Harold H. Shepaed, *Aassistant Professor of Entomology, University of Minnesota.* Cloth. 15.5×23 cm. Pages vii+247. 7 figures, 4 color plates, 38 photographs. University of Minnesota Press, Minneapolis, 1941. $3.50.

The chief purpose of this book is to make accurate identification of butterflies easy. Along with this the authors tell of ancient beliefs concern-

ing butterflies, curious items about their life histories and habits, how they hear, see and smell, also their migrations and habitations; records of early and late appearances, habitats and geographical distributions. A significant feature is reference material of recent date. 189 butterflies are described and keyed. This book should be of partidular interest to any biology teacher who gives his biology teaching a nature study slant.

A. G. ZANDER

THE SECOND YEARBOOK OF RESEARCH AND STATISTICAL METHODOLOGY, edited by Oscar Krisen Buros. Cloth. Pages xx+383. 19×27 cm. 1941. The Gryphon Press, 32 Lincoln Avenue, Highland Park, New Jersey. Price $5.00 less 10% on orders sent direct.

This is the second volume which attempts to present critical reviews of research and statistical methodology books. It is very distinct from the usual publication but fills a definite need in that it combines into one place many reviews which would be otherwise inaccessible. In most cases one has available both praise and criticism of any book. Although in some cases reviews had to be condensed in the interest of brevity, comparison of several such condensations with the original indicates no serious omissions.

This work very definitely has value as an aid in selecting textbooks or reference books for the library. As contrasted with the first volume, more material is presented, an attempt has been made to include classes of books poorly represented in the first volume and reviews are quoted from more periodicals. The indices include a periodical index, a publisher's index, an index of titles, an index of names, and a classified index. While some might question the inclusion or exclusion of certain material, there is certainly at present nothing available which will begin to serve the purpose of this volume.

CECIL B. READ
University of Wichita

OUTLINE OF THE HISTORY OF MATHEMATICS, by Raymond Clare Archibald, *Professor of Mathematics, Brown University*. 5th edition, revised and enlarged. Paper. Pages ii+76. 15×23 cm. 1941. The Mathematical Association of America, Inc., Oberlin, Ohio. Price $.75.

This is the 5th revision of this very popular outline. The author states that the revisions and additions are more extensive than in any previous edition. The pamphlet is a very excellent source of material either for a course in the history of mathematics or for supplementary material in any course. The index of names fills a need evident in previous editions. Because of typographical limitations, it should be pointed out that much valuable material appears in the literature list and notes, rather than in the text proper. The bibliography is a very valuable source of material for mathematics clubs.

CECIL B. READ

Asked if he could summarize the lessons of history in a short book, Dr. Charles A. Beard, American historian, replied that he could do it in four sentences:

1. Whom the gods destroy they first make mad with power.
2. The mills of God grind slowly, but they grind exceedingly fine.
3. The bee fertilizes the flower it robs.
4. When it is dark enough you can see the stars.

—*The B. C. Teacher*, December 1941.